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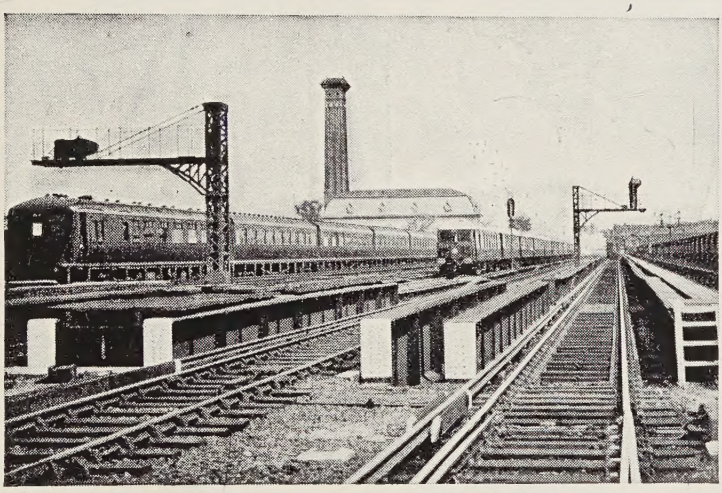

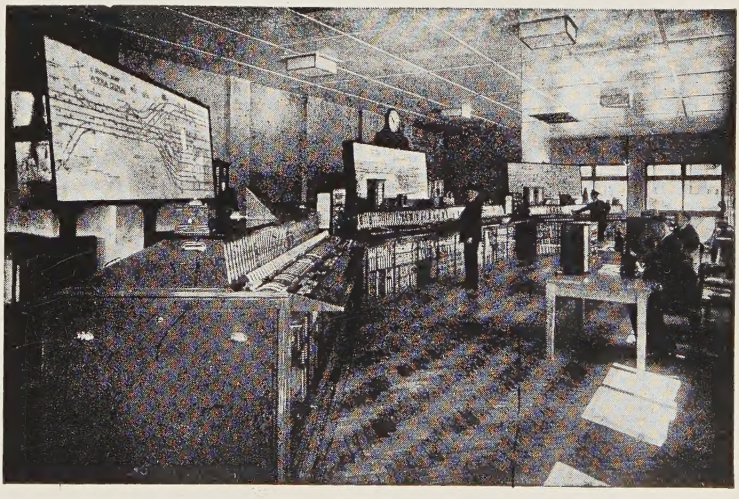

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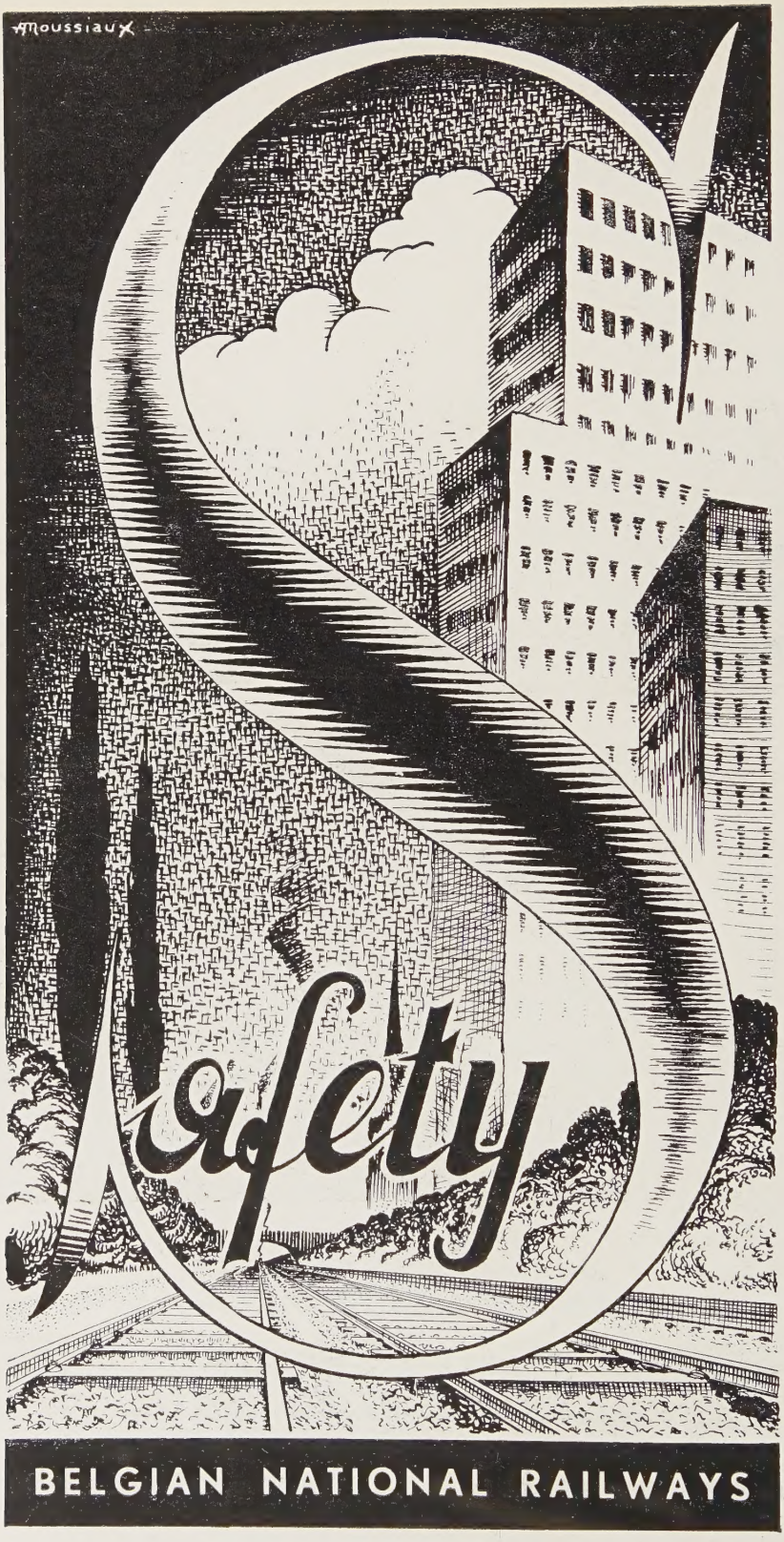
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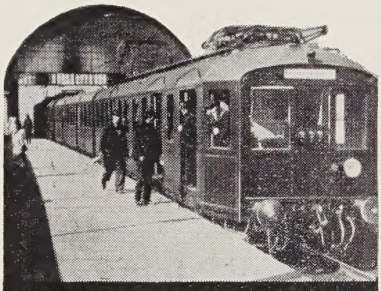

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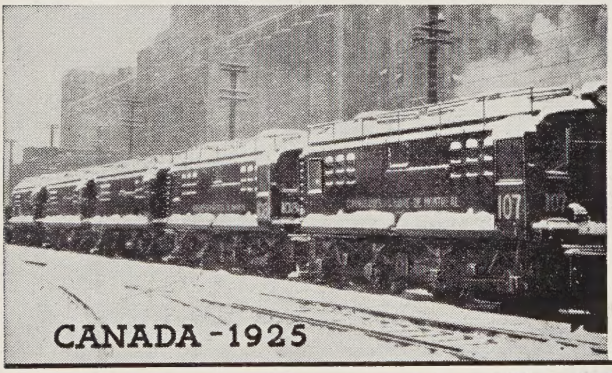

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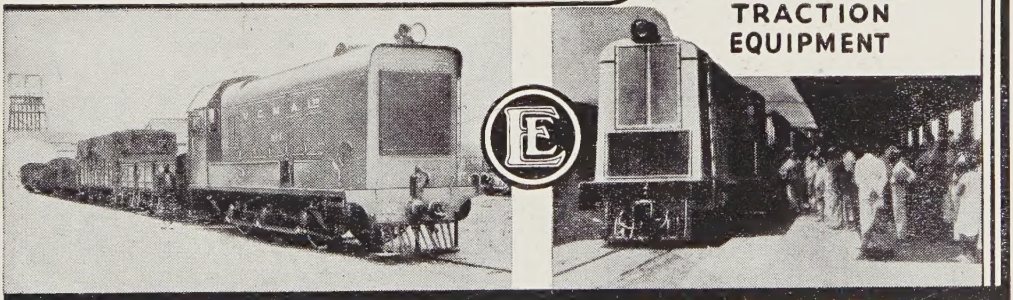

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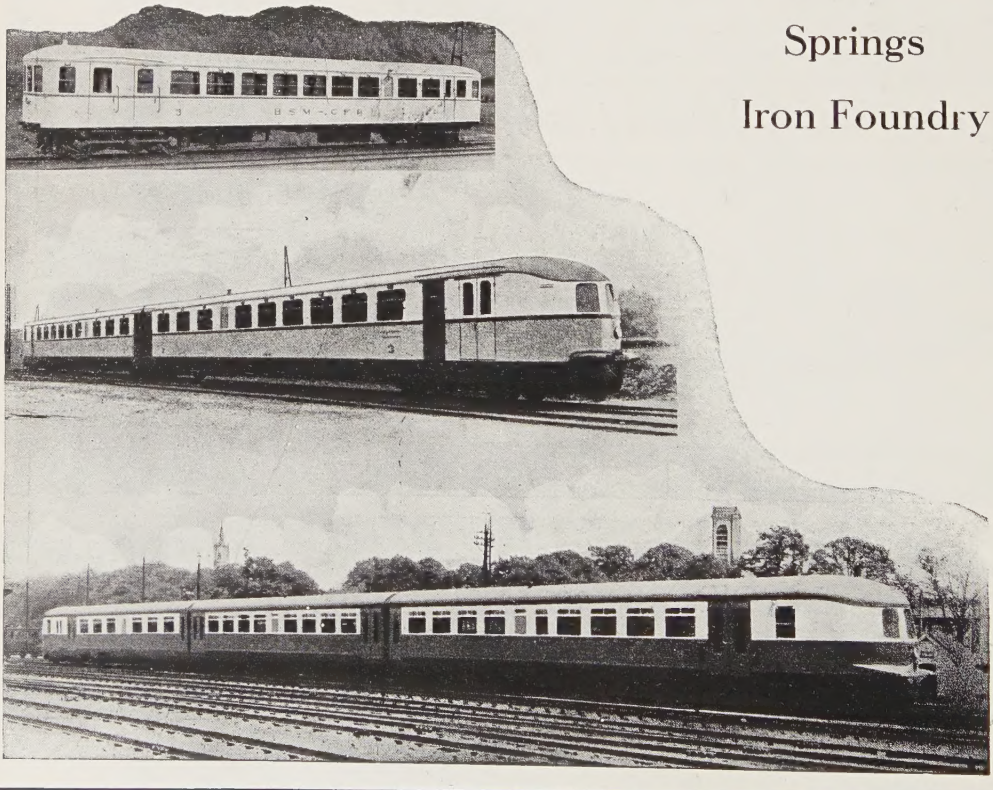

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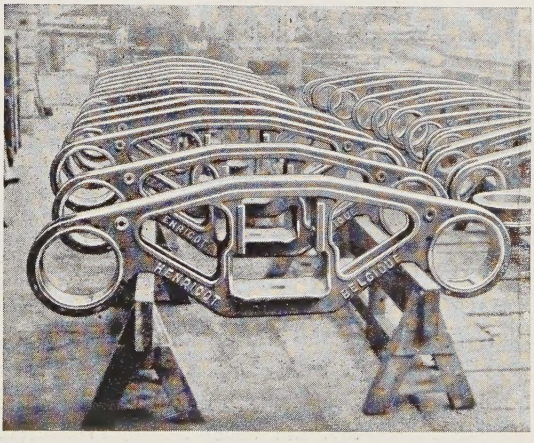

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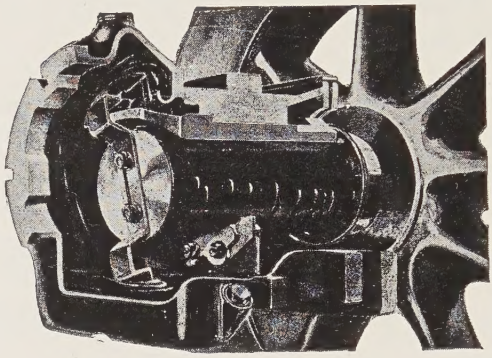

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MONTHLY BULLETIN

OF THE

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

(ENGLISH EDITION)

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employ *temporary staff* (assistants and standbys for the level crossing services, temporary staff of the permanent way and operating departments), as well as *building operatives* (workmen supplied by private contractors). The two latter categories have never reached any considerable figure. In *1945*, the different categories of staff were made up as follows :

Permanent staff :		
Officials	22 475	
Clerical staff	1 881	
Operating staff	2 670	
Workshop staff	2 857	
Apprentices	793	
		30 676
Temporary staff		2 320
Building operatives		1 429
Total		34 425

It should been noted that up to the present the workshop grades have not been considered as « staff ». But the Administrative Council of the Federal Railways now intends to give them this status. Consequently, as soon as this decision has been ratified by Parliament, the number of permanent staff will be increased by the number of men employed in the shops. Various motives inspired this decision : considerations of a social nature, the permanent position of shop employees, competition of private industry, etc.

In 1944 the permanent staff was divided up amongst the different departments as follows :

General Management	2.3 %
Station and Train staff	54.2 %
Permanent way and power stations	17.8 %
Traction	14.1 %
Workshops	11.0 %
Auxiliary services	0.6 %
	100 %

Whereas in 1939 the average number of employees per kilometre of line was 9.16, this number exceeded 10.39 in 1945.

These various statistics require some comment. First of all, if the number of employees, in spite of the wartime increase in traffic has remained at a fairly low level, this was not managed without some difficulties and drawbacks. One of the results of the policy of reducing the number of employees practised before the war was that a sufficient number of employees was not always available. On the other hand, the Federal Council passed a decree on the 15th. September 1939, which extended the obligations of the railway staff, but on the other hand limited the observance of the laws on working hours, holidays, and free time, as well as special bonuses; this decree led to certain additional work and abnormal conditions, the result chiefly of the many additional working hours and giving up of legal days off to which the staff had to agree. It was not always possible to carry out the training of apprentices and the professional education of employees to the extent desired. However, the fact that the staff was maintained at a rather low level all during the war had the result that the Federal Railways had no redundant staff at the end of the war which it was hard to absorb into industry, as was the case after the first world war.

The requirements of the staff are essentially a stricter application of the law on working hours and additional pay to make good the rise in the cost of living. Although the measures passed by the Federal Authorities have only made it possible to raise the wages of employees by amounts that only partially compensate for the increase in the cost of living, and in spite of the many additional duties

imposed upon them, the railway staff during the whole period of the war proved itself to be well disciplined and endowed with a fine sense of duty, as the authorities as well as the public have been pleased to recognise.

VII. — Finances.

1. Pre-war period.

For the first 11 working years of the Federal Railways, i.e. from *1903* to *1913*, the net credit balance of the profit and loss account only amounted to 22 million Swiss francs. For seven working years there was a credit balance of 33 millions, while the four other years showed a debit balance of 10 millions in all.

This far from favourable result despite the great hopes that had been placed in nationalisation, was due in part to the excessive purchase price that had to be paid, a sum exceeding the overhead charges by 114 million francs and greatly in excess of the value of the returns that the undertaking could earn. The consolidated debt which amounted to 1 075 million francs at the end of 1903 had reached 1 494 by 1913.

The *second period*, from 1914 to 1922, was marked by the first world war. The total operating deficit then reached the huge amount of 317 million Swiss francs. The year 1921 alone, with an operating coefficient of 96 %, resulted in a deficit of 72.5 million francs, the highest to date. The total debt increased from 1.5 thousand million to two thousand million francs. It may be said that the Federal Railways were then sacrificed in the national interest. The rates were hardly increased at first, although the price of coal was already seven times more than before the war. The Federal Authorities did not agree to a fair increase in the rates until 1920. The payment for *military transport* was also insufficient. In spite of the very small compensation afterwards allocated, this transport alone involved a loss of 16 million francs. In addition, in order to assure the provisionning of the country the Federal Railways had to place special orders for *wagons*, which cost 30 million francs. They also lost 47.5 million francs on account of the taking over of stocks of coal accumulated in the public interest by the Coal Syndicate. The special charges borne by the undertaking during the war and the first years after the war amounted to 459 million francs, to which interest must be added. The Confederation only awarded the railway a small grant of 35 millions in 1929, whereas in most other countries the State bore the whole burden of deficits due to the war.

The years between *1923* and *1930* were not quite so difficult for the Federal Railways, seeing that the *gross credit balance* of the profit and loss account amounted to *37.6 millions*, after deducting the 1926 debit balance of 9 millions. This period was marked by the first reorganisation of the undertaking, which consisted in simplifying the administrative procedure and taking the initial rationalisation steps. These facts, added to the improvement in the general economic situation, contributed to an improvement in the operating results. Nevertheless, the sinking fund showed a deficit of about 15 million francs a year. If sufficient amounts had been set aside for the sinking fund, this period also would have ended in a new deficit of about 66 million francs. In addition the consolidated debt continued to increase regularly, reaching a total of 2 713 million francs at the end of 1929, which meant paying 115 million francs in in-

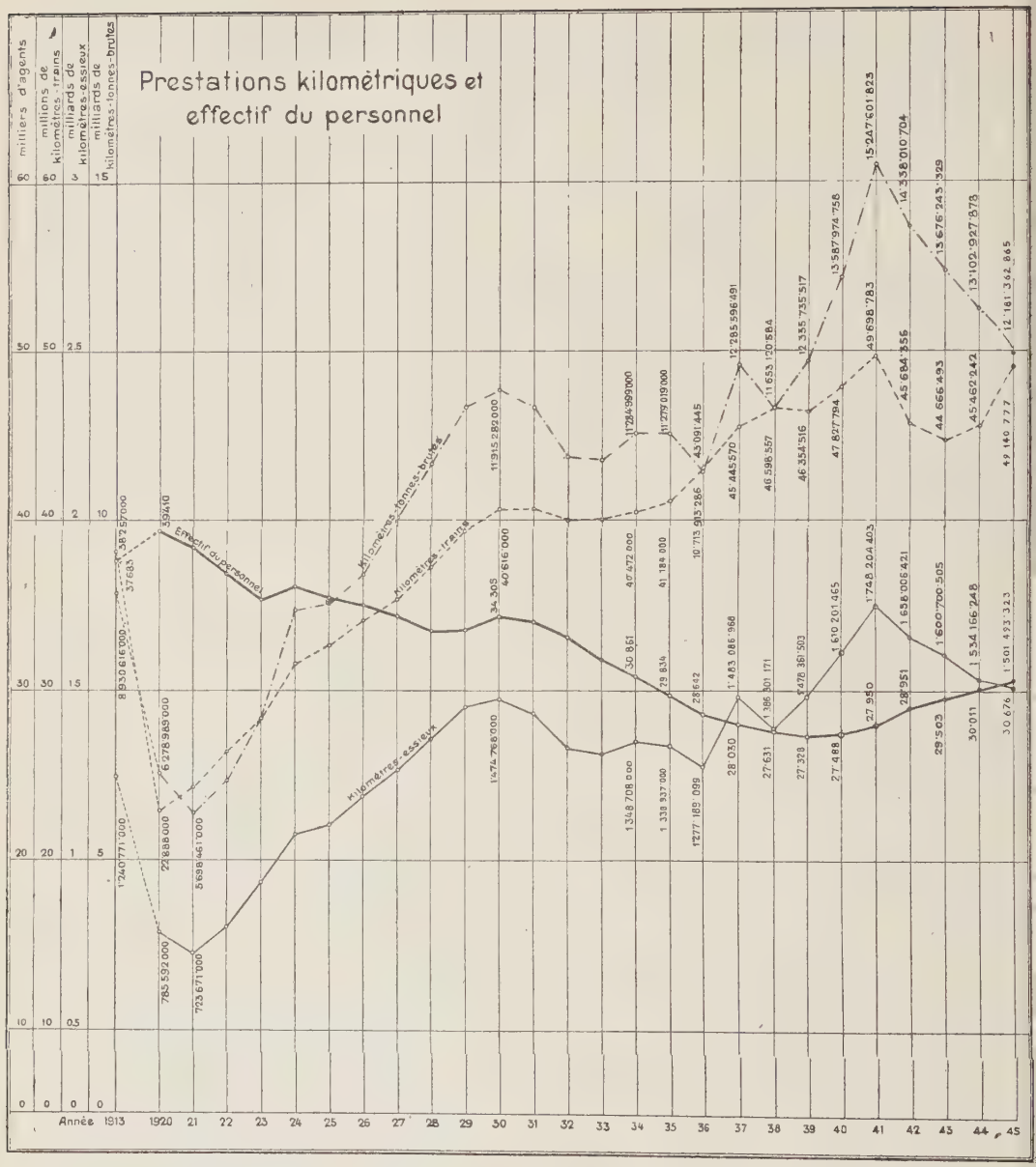


Fig. 8. — Kilometric statistics and number of staff.

Explanation of French terms :

Milliers d'agents = thousands of employees. — millions de km./trains = millions of train/km. — milliards de km./essieux = wheel/km in thousand millions. — milliards de km./tonnes brutes = Gross ton/km in thousand millions.

terest. This was the weak link in the finances of the railway, as the future was to prove, since the undertaking was totally without proper working capital.

Finally, during the *fourth period from 1930 to 1939*, the Swiss Federal Railways suffered from the effects of the economic crisis and competition from motor transport. The passenger and goods traffic both continued to fall off until 1936, after which they recovered slightly when the franc was derated. An official enquiry, held between the 1st. July 1936 and the 30th. June 1937, estimated the goods traffic lost owing to the competition of motor transport at 40 million francs a year, while the loss in passenger traffic was estimated at between 10 and 15 million francs. It is certain, however, that the general crisis revealed by the corresponding reduction in the customs receipts of the Confederation, was probably the essential cause of the fall in operating receipts during this period. The debit balance of the profit and loss account reached 67 million francs in the year 1936 alone. The total for the whole of this period (1930-1938) amounted to 328 million francs.

2. The war years.

1939. — The *operating account* includes the results of the actual operation of the railway. The results of the subsidiary undertakings (power stations, shops, navigation and catering) are not shown in this account, but the net receipts are credited directly to the profit and loss account. In 1939, the passenger traffic receipts remained almost stationary, while the goods traffic receipts showed a considerable increase (40 million francs more than in 1938). On the other hand the operating costs fell to the lowest level they had ever reached, in spite of the increase of traffic due to mobilisation for the war. The cost of wages for example, decreased from 186.1 million francs to 183.2 millions in 1938. The operating coefficient was 61.99. The *profit and loss account* for the first time since 1930 showed a credit balance of 7.5 millions (against a debit balance of 35.2 millions in 1938). This credit balance, the fifth since the creation of the Federal Railways, was however a hypothetical one so long as adequate provision was not made to pay off the capital invested, which was not done until 1941. On the other hand, the special sinking fund had been greatly increased. In addition, a special allocation of 15.3 million francs (nearly a million more than in the previous year) was made to the pension and staff benefit fund, which was very short of funds.

1940 was the first year of the war properly speaking. In spite of the increase in passenger traffic, the corresponding operating receipts remained much lower than those of 1930. The goods traffic receipts continued to increase, exceeding those of 1939 by 33.7 millions and those of 1929 (the best pre-war year from this point of view) by more than 2 millions. The total increase in the operating receipts, nearly 3 millions, corresponded to the increase in the goods traffic receipts. On the other hand, the operating costs increased by 6.6 % in comparison with 1939, which was very little when the already considerable increase in the traffic is taken into account. Staff costs had not as yet increased to any great degree. The *profit and loss account* showed a credit balance of 13.4 millions, i.e. 5.9 millions more than 1939, while the operating account showed an improvement of 21.8 millions compared with 1939. This difference

was due to two factors : on the one hand, in view of the great reduction in permanent way work due to the shortage of materials, the items against the renewal funds which figure as receipts in the profit and loss account had decreased by 3.36 millions compared with 1939; on the other hand, the expenditure under the heading « Sums allocated to sinking funds » had risen by 10.51 millions owing to the unusually heavy writing down of no-value items in order to audit the balance-sheet. Finally, the interest due led to an increased expenditure of 1.6 million. The *operating coefficient* was 60.02.

1941. — The passenger traffic receipts for the first time exceeded (by 1.5 million) those of 1930, the highest pre-war year. They exceeded those of 1936 by 40 millions and those of 1940 by 25.4 millions. The goods traffic receipts reached their maximum of 278.4 millions, so that the operating receipts amounted to 455 millions. For the first time the cost of living bonus granted to the staff had a considerable effect upon the operating expenses (21.8 millions more than in 1940). The *operating account,* however, showed a net profit of 194.4 millions, i.e. 35.4 millions more than 1940. This large operating credit balance however only led to a relatively small improvement in the *profit and loss account,* which showed an excess of receipts over expenditure of 18.47 millions (5.07 millions more than in 1940). This was due first of all to the increase in the sinking fund, which had long been necessary and was the most striking financial event of the year. In addition, a new item « Reserves for operating costs » amounting to 14 million francs, was added on the debit side, to be set aside for the replacements and renewals of the permanent way, the full programme of which could not be carried out during the war owing to the shortage of materials. In addition, various accidents and fires involved spending 2.49 millions as assurance against fire and accidents. Finally, the additional contribution to the pension and benefit fund was increased from 15.83 to 18.32 million francs. The *operating coefficient* fell to 57.28 which represents the *lowest* coefficient since the creation of the Federal Railways.

1942. — The operating receipts increased once again as a result of war conditions; the operating costs also increased owing to the general increase in prices, which gradually led to an increase in costs and wages. The increase in the receipts, however, had already begun to follow a different course from the increase in costs, which continued to rise. Whereas in 1941, the increase in receipts amounted to 35.36 million francs more than the increase in costs, in 1942 on the contrary the latter exceeded the former by 14.45 millions. The *profit and loss account* was balanced with a credit balance of 2.5 millions, a decline of 15.97 millions compared with 1941.

1943. — The *operating account* showed a new increase in the passenger receipts, but also a decrease in the goods receipts. The total operating receipts, however, amounted to 479.2 million francs, i.e. still 10.9 million francs more than in 1942. The operating costs followed a rising curve, and exceeded all figures to date, except for the years between 1920 and 1921. The causes of this increase were essentially the higher wages paid to the staff (increased cost of living bonuses and increase in number of employees), and the increase in the cost of maintaining the

permanent way. The system had to deal with very heavy traffic and the shortage of materials which prevented many re-conditionings of the track entailed a great deal more maintenance work. The balance of operating receipts over costs was however 163.3 millions (16.3 millions less than in 1942). The *profit and loss account* only showed a net balance of 0.4 million francs. This appreciable decline, in spite of the increase in traffic, shows to what an extent it had become necessary to put the undertaking on a rational basis, a question that was then being discussed by the Chambers.

1944. — The operating receipts for the first time exceeded 500 000 millions, being 504.68 millions. The increased rates introduced in the spring account for 31.5 of this total. But the operating expenses continued to increase more than the operating receipts and reached 345.24 millions, i.e. 29.67 millions more than in 1943. The difference was due to the same causes as in the previous year. The cost of living continued to rise and increased the cost of materials. The profit from the *operating receipts* (159.44 millions) was only just sufficient to prevent the *profit and loss account* from showing a loss once more. The account closed in fact with a net balance of only 0.02 millions. The operating coefficient rose to 68.41.

In *1945*, the last year of the war, the evolution of the previous year continued. A further increase in the operating receipts which amounted to 511.6 million francs — the best result ever obtained by the Federal Railways — together with an increase in the operating costs, which reached the record figure of 365.2 million francs, thereby exceeding those of 1920, the highest pre-war year. The balance of receipts over costs was 146.43 millions, 13.01 millions less than in 1944. The *profit and loss account* showed a *loss* of 25.6 million francs. The law to put the railway on a rational basis, passed by the Chambers on the 29th. June 1944, had not yet come into force at that period. According to this law, the 1945 deficit would be taken over by the Confederation. If this law had come into force in 1945, the Confederation would have had to pay 43.6 millions instead of 25.6 millions, to correspond with the interest on the loans which it took over by the new law. On the other hand, the Federal Railways would have been able to pay 8 million francs into the reserve fund instituted by the law in addition to paying the Confederation interest of 3 % on the new capital funds they were to be granted.

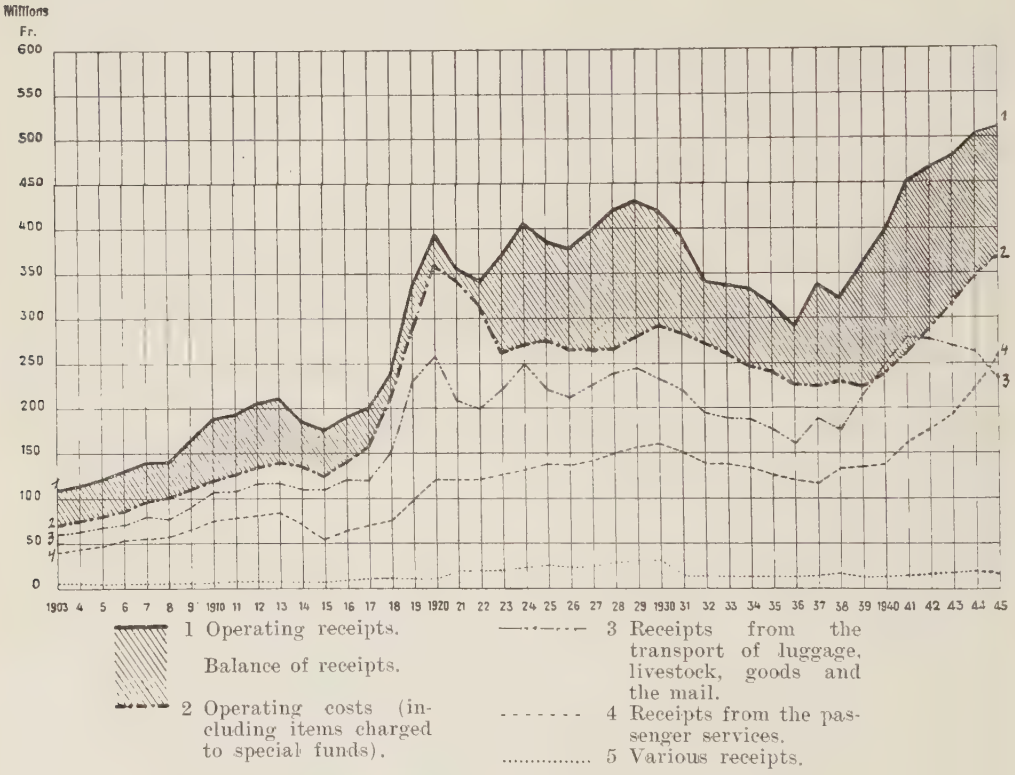
Figures 9 and 10 show the operating results for the years 1939 to 1945, together with the profit and loss account.

VIII. — The rationalisation of the undertaking.

As far back as 1933, the Administrative Council of the Federal Railways drew the attention of the Federal Authorities to the financial position of the national railways. The financial results of the first years of the economic crisis made it impossible to wait any longer. The Department of Posts and Railways (or Ministry of Transport) immediately decided to make the necessary investigations in order to put the railways upon a rational basis. A preliminary project was drawn up in 1934, but the Federal Council judged it advisable to settle the railroad dispute first of all. It seemed at that time that the problem of the Federal Railways could not be solved in a satisfactory way till the relations between the

two chief methods of transport had been regulated. However, the first attempts to cor-ordinate the activities of the two methods of transport ended by the proposed law on the division of the traffic being rejected by the people, on the 5th. May 1935.

clear that the private railways would first of all have to be assisted before the rationalisation of the Federal Railways could be achieved, since all the Companies operating these also were very much in debt. This was undertaken by the law of 1939.


Millions
Fr.
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1903 4 5 6 7 8 9 1910 11 12 13 14 15 16 17 18 19 1920 21 22 23 24 25 26 27 28 29 1930 31 32 33 34 35 36 37 38 39 1940 41 42 43 44 45
1 Operating receipts.
Balance of receipts.
2 Operating costs (including items charged to special funds).
3 Receipts from the transport of luggage, livestock, goods and the mail.
4 Receipts from the passenger services.
5 Various receipts.

Fig. 9. — Balance of receipts for 1903-1945.

The same year, the question of the rationalisation of the Federal Railways was once more raised, and a plan was put before the Federal Council on the 24th. November 1936, which was discussed by the National Council in 1938. However, the attitude of certain Cantons with particular interests in private railways made it

On the other hand, the deliberations regarding the rationalisation of the Federal Railways came up against various difficulties. The National Council refused to alter the status of the railway staff, the greater part of whose employees were agents of the Confederation. Various people were of the opinion that

the undertaking should have more freedom as regards its staff, and that employees should not be classified as Federal officials any longer, like the other employees of the Central Administration of the Confederation. The National Council would not agree to this proposal, was now based on the average returns of the Federal Railways over a period of 12 years, including profitable and less profitable years, marked by the effects of the crisis and motor competition.

Finally, the sinking fund system was re-organised according to new uniform

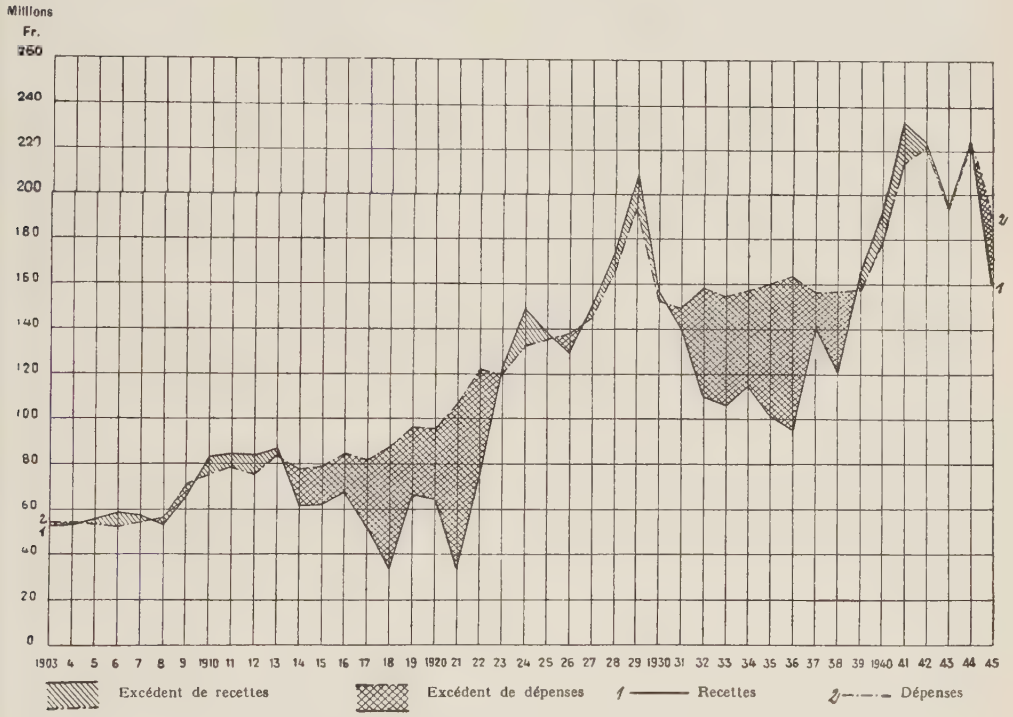


Fig. 10. — Profit and loss account for 1903 to 1945.

Explanation of French terms :

Excédent de recettes = Balance of receipts. — Excédent de dépenses = Balance of expenditure. — Recettes = Receipts. — Dépenses = Expenses.

which it deemed to be contrary to a progressive social policy.

In addition, the material conditions under which rationalisation was to take place had altered. Instead of calculating the required financial readjustment based on an assumed commercial depreciation of the undertaking as in 1936, this measures laid down by the Postal and Railway Department which were to apply to all the Swiss Railways, so that it was a considerably modified proposal that was put before the Chambers in the winter of 1943 and passed by Parliament on the 23rd. June 1944. Shortly afterwards a popular referendum was brought

against the new law. This, in accordance with the Swiss Constitution, had to be put to the vote of the nation if 30 000 signatures were obtained to the referendum; 35 000 were obtained. Voting took place on the 21st. January 1945; the vote of the Chambers was ratified by 388 000 votes against 296 000.

The debt of the Swiss Federal Railways amounted to 3.25 thousand million francs in 1939. During the war, this debt was reduced by 120 millions. Thanks to the rationalisation measures passed by the Confederation, the debt was reduced to 1.8 thousand million francs. The calculation of the returns of the undertaking during the years 1927 to 1938 did make it possible in fact to allow this debt to be left against the undertaking. The Confederation took over a debt of 900 million francs, as well as the interest thereon, which amounted to approximately 50 million francs a year (fixed repayment), while the Federal Railways were given an endowment at varying rates of interest of 400 millions (varying repayment) which gave the undertaking what it had lacked to date, namely a proper working capital, which gave its unduly rigid financial structure the flexibility so far lacking.

The 1936 project went further in its rationalisation measures, according to which the undertaking would have benefited to the extent of 1 530 million francs. It has been questioned at various times whether the solution finally adopted was sufficiently far-reaching. It was in the opinion of the Federal Council, which considered on the one hand that many of the causes, which had led to the endebtedness of the Federal Railways, were due to outside circumstances beyond the control of the undertaking (too high purchase prices of the railways, high cost of electrification made after the 1914-1918 war, insufficient sinking funds, cost of the previous war for which the undertaking was inadequately indemnified), which were not likely to recur, and on the other hand that the Confederation, already burdened by heavy financial obligations, could not afford to do more than was strictly necessary.

The new law on the Federal Railways not only handed over part of the debts of the Railways to the Confederation, it also contained numerous clauses intended to prevent as far as possible future deficits and charges not belonging to the working. For example, expenditure on purchases and constructions carried out by the Federal Railways had in future to be covered entirely by resources from the sinking fund. If the resources from this fund were insufficient to cover the new expenditure, and it was necessary to augment it by further borrowing, this could only be done after the matter had been put to the vote of the Nation by a Federal Decree. The consent of the people is therefore expressly required by law to all new loans to the Federal Railways, which will add to the amount of their endebtedness.

The consent of the Nation is also required in another eventuality. Article 2 of the law lays down in effect that the Confederation cannot acquire new railways or build new lines except by Federal Decree submitted to a referendum.

In addition, in the case of the acquisition of new lines, the sum expended for this purpose must not exceed the commercial value to the Federal Railways of the line to be acquired or built. In this way, the mistakes made at the time the railways were nationalised cannot be repeated.

Finally, it is laid down that the defi-

cits which may occur in the future shall no longer simply be referred to a new account or covered by new loans, but must be met from a reserve fund set up for this purpose, into which 8 million francs a year must be paid out of the net profits for the year, until this reserve fund amounts to 20 % of the capital funds of the undertaking (i.e. 80 million francs). Should this reserve fund be exhausted, the Federal Chambers must legislate on the way it is to be covered. This will prevent deficits being accumulated.

This in its outlines is the new law on the Swiss Federal Railways, which came into effect retrospectively on the 31st. December 1945.

We give below the balance sheet as at the 31st. December 1939, the non-rationalised balance sheet as at the 31st. December 1945 and the rationalised balance sheet as at the same date :

1. Balance sheet at the 31st. December 1939.

Credit.	*Millions of Swiss francs.*	*Debit.*	*Millions of Swiss francs.*
Overhead charges :		Consolidated debt	2 691.3
Constructions account 2 517.2		Capital repaid	117.7
Difference between purchase price and overhead charges . 114.0		Amounts owing	561.4
		Special funds	232.6
	2 631.1	Credit balance for 1939 . . .	7.5
Work being done	51.0		
Subsidiary undertakings . . .	266.1		
Sinking-fund	237.4		
Assets and credits	153.4		
Deficit for years 1931 to 1938	271.5		
	3 610.5		3 610.5

2. Balance sheet at the 31st. December 1945 prior to rationalisation.

Credit.	*Millions of Swiss francs.*	*Debit.*	*Millions of Swiss francs.*
Overhead charges	2 816.3	Consolidated debt	2 864.0
Work being done	48.4	Amounts owing	342.3
Auxiliary services	239.2	Special funds	10.4
Sinking fund	271.0	Capital repayments	627.2
Assets and credits	223.6		
Deficit at end of 1944 . . .	219.8		
Deficit for 1945	25.6		
	3.843.9		3.843.9

3. Balance sheet at the 31st. December 1945 after rationalisation.

Credit.	*Millions of Swiss francs.*	*Debit.*	*Millions of Swiss francs.*
Capital assets	2 066.7	Real capital	410.4
Realisable assets	167.3	Reserves	64.4
Other credits	51.4	New capital	1 805.6
Deficit for 1945	25.6	Other debits	30.6
	2 311.0		2 311.0

IX. — Co-ordination of methods of transport.

The law on the division of the traffic which the Federal Chambers voted on in 1934, which was rejected by the Swiss people in 1935, consisted of two essential parts. The first introduced the system of obligatory concessions for the transport of goods and livestock. The second laid down the principles of co-ordination between rail and road. This co-ordination was to be based upon an agreement between the parties concerned (railways, motor transport, post office), which the Federal Council had to approve. Only when no agreement could be reached between the various parties was the Federal Council to intervene, by taking steps to divide up the traffic according to the principles laid down by the law. The fundamental idea of this division of the traffic was to give the railway in principle all long distance goods traffic. Any transport over more than 30 km. (18.641 miles) was to come in this category. If the distance was greater than this, the transport could only be granted to concession holders when there was no railway service, or on routes where it was rational to hand it over to motor transport.

This law met with very strong opposition. It is incontestable that it did in fact limit motor traffic too rigidly. It was rejected by a large majority.

After this failure, the Federal Authorities came up against other problems. In 1936, there was first of all the rationalisation of the Federal Railways to be considered. Then came the law on the rationalisation of the private railways, which held their attention from 1937 to 1939, the carrying out of which took the whole of the war period. In the interval, however, the problem of the co-ordination of transport had been magnified. Under the effects of the general crisis, competition between road firms had become more and more serious (multiplication of services beyond any possible need for them, price cutting, etc.).

This led the Federal Council, after a thorough investigation of the problem based on road traffic statistics, to submit a law to the Chambers on the transport of passengers and goods by means of motor vehicles, which was adopted as a measure of urgency in 1938. This was the *motor transport statute (STA)* which introduced a system of concessions for all professional transport of passengers and goods, and made the granting of a concession dependent upon the traffic requirements and the condition that the holder was able to give the necessary personal and financial guarantees for the

safety and efficiency of the service.

This decree, however, left certain gaps, both from the constitutional and economic points of view. Properly speaking, it did not co-ordinate the traffic, although it controlled to some extent the plethora of road transport services. It did not arm the law with all the necessary authority for instituting a proper system of co-ordination.

To remedy these drawbacks a new drive was made in 1938 to introduce an article on the co-ordination of transport into the Federal Constitution. This went back to the idea of the law of 1934, and in principle all long distance transport was reserved for the railway, without any definite mileage being laid down however.

The proposed law was considered very unsatisfactory however by the Federal Chambers. They thought that the restrictions on long distance road transport were excessive. In addition, they considered that some constitutional decree was essential to give the Confederation the right to co-ordinate *all* the methods of transport, so that this would form a responsible whole, each element of which could develop harmoniously. The Swiss Parliament therefore adopted an article worded as follows solely for this purpose :

« The Confederation co-ordinates by legislation, in the sense of Article 89, paragraph 2, of the Federal Constitution, railway transport and motor transport on the public roads, by water and by air, in conformity with the interests of public economy and the national defence. For this purpose a law will regulate in particular co-operation and competition between the different methods of transport. It may if necessary over-ride the principle of freedom of commerce and industry. »

This article merely gave the Confederation the right to pass laws to co-ordinate transport. It did not introduce any method of co-ordination; this was to be the subject of future legislation to be submitted to the Chambers, on which the Swiss people would *necessarily* be called to vote.

However, even this general statement was not agreeable to the people who rejected it by a very large majority. Wearied by the restrictions of the war period and the innumerable regulations imposed by the authorities in every field during these years, the people who are lovers of liberty took the first chance they had of expressing their disapproval. It was unfortunate, however, that it had to be on such an important question.

Nevertheless, in Switzerland the question of co-ordination has come to a dead end. In the meantime, motor traffic has recovered to a very large extent, and its effects are beginning to be felt once more in the case of passenger traffic, although the latter remained at a high level during the first quarter of 1946. The motor transport statute (STA) of 1938, introduced in 1940, continues to have a moderating influence on professional passenger and goods transport services, as its period of validity has been extended to 1950. Mixed transport (private firms carrying out transport on behalf of third parties against payment) is still forbidden. On the other hand, private transport is entirely unrestricted.

In addition, another method of transport has developed to an extent unforeseen before the war, i.e. the airplane. In this field also the problem of co-ordination arises. It is perhaps less acute in Switzerland, seeing that the airplane has not the same advantage for inland transport as in more extensive countries. It raises very important problems however, which the railway will have to solve even in Switzerland, if important traffic is not to be lost.

X. — Information, propaganda and publicity services.

The problem of the relations between a State railway and the public has always been a delicate one. Undoubtedly, for many long years, the Swiss Federal Railways suffered from a widespread misunderstanding. As soon as it is question of a public service of this magnitude, public opinion becomes very exacting; criticism is often malicious, even frankly biased. Certain people, completely ignorant of railway matters, feel competent to express bold and unjust judgments, which are often completely fantastic. Consequently the railway itself, by making use of the most up-to-date technical methods, must enlighten the public and explain the working of the system and show how the railway is operated above all to serve the public, and what the public can expect. During the last few years, the Federal Railways have been most succesful in this direction, and the war period did not interrupt this work. On the contrary, making use of the time when serious transport problems were being discussed in Parliament and being put to the vote of the people, they continued the work which had only been started previously, and perfected their methods.

Amongst the chief methods used, mention may be made of the following :

1. — The *press service* of the general secretariat sends illustrated reports to all the papers and periodicals, concerning all operating matters, and also gives first hand information to journalists and reporters. It also draws up the official press notices. Every two months, or more often if necessary on account of internal administrative needs, a *detailed press report* is drawn up describing the main events which have occurred in the field of transport, giving extracts from the leading technical and political papers. The collection of the press services will therefore form a very valuable source of information in the future.

2. — Valuable *photographic archives* have been collected which are used both by the Administration itself and by the press and publishing houses. A collection of negatives of reduced size which now totals some 22 000 has already proved of great value.

3. — Steps have been taken in order to interest the *students* in the railway. Lecturers are available for the schools. Textbooks have been prepared in the three national languages for young people (« The Railway at the service of the country »). A private publishing firm has also published several books of illustrations with a commentary for children, which have had a widespread success. In close collaboration with the educational authorities an *educational film* (« We travel on the railway ») has been made for the use of schools.

4. — The *Swiss Cine-Magazine*, which was shown at all picture houses during the war, dealt with several railways subjects. The Federal Railways also had a long *documentary film* made about the railway.

5. — The *Swiss broadcasting services* have had several programmes devoted to the railway. The Geneva Studio gives a talk every Wednesday in the series, « Rail, road and wings ».

6. — In 1945, the Federal Railways inaugurated a « *concours d'idées* » (brains trust) in which more than 6 000 people took part.

7. — *Special visits* are organised for

the press on certain occasions such as the inauguration of newly electrified lines, or new rolling stock, tunnels, commemoration of certain historical events, etc.

8. — The *Monthly Bulletin of the Swiss Federal Railways* is the mouthpiece of the undertaking and a source of information for the political dailies and the technical press.

9. — *Books* have been published under the auspices of the Federal Railways in order to give the general public some idea of the organisation of the railway. We might mention in particular the collection of Swiss Federal Railway pamphlets, two of which have so far been published : one dealing with locomotives, the other with stations. A bigger work, with beautiful photographs, is entitled « *The secrets of the railway* ».

10. — Since 1946 the Federal Railways have sponsored the publication of a *scientific review* which covers the entire field of transport, entitled « *Swiss economic archives* ». This review, the editor of which is thoroughly impartial and objective, fills long-felt want.

11. — At certain times, a *publicity campaign* has been undertaken in the political and professional press in order to inform the public on the activities of the undertaking (Mid-June, End-July 1943). (Figs. 11-12).

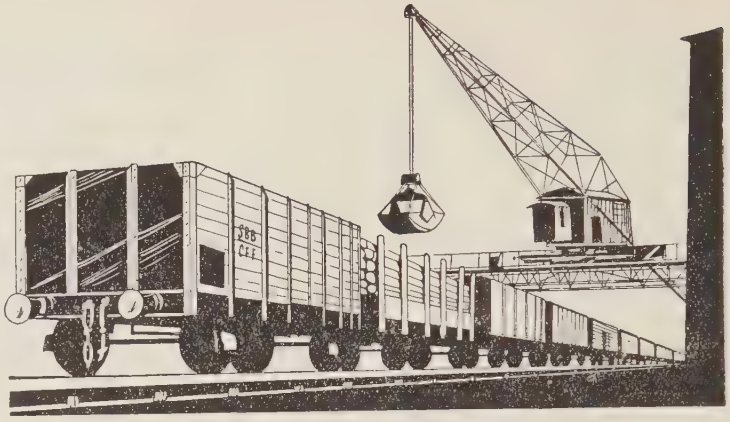
12. — Finally, on the two important occasions when *voting* was taking place on the rationalisation of the railways and the co-ordination of transport, the Federal Railways shared in the publication of pamphlets explaining the scope of the legislation submitted to referendum : « *The new law on the Federal Railways* » published on the occasion of the vote on the 21st. January 1945, and « *For co-ordination of transport* » a pamphlet published in 1946 by the Working Committee in the case of the constitutional article on the co-ordination of transport.

13. — Besides the above sources of information, there is also a *publicity service of a purely commercial nature* (leaflets, posters, pamphlets and prospectus giving details of the rates, travel facilities, the main lines of the system, the Swiss Federal Railway Calender, organisation of lectures, etc.).

It is quite certain that this educational and publicity campaign is beginning to bear fruit. The public are showing a better understanding of the railway, the young people are becoming interested in it, and the staff itself is profiting. None of these measures have been excessive however in view of the existence of a hostile press that campaigns against the railway, a press which has at its disposal several large weeklies and important reviews. The Swiss Federal Railways do not wish to bring any pressure to bear upon public opinion, but only to fight the anti-railway campaign by modern methods. This right, which belongs to all commercial undertakings, is no longer denied them.

XI. — Future prospects.

It would take us too long to ennumerate all the other points to which the Federal Railway Administration devoted its attention during the war period. We will only mention the *rationalisation* of the office work. The creation of a Planning Section is under consideration, which will investigate the best methods of working. The arrangements of the stations in particular, has been the subject of thorough investigations, which have already had good results. The ra-



THE PART PLAYED BY THE SWISS FEDERAL RAILWAYS.

Agriculture requires tools and machinery, seeds, feeding stuffs and fertilisers. The towns need milk, vegetables, fruit and meat. The manufacturers require coal, iron and other raw materials coming from abroad. It is the Swiss Federal Railways who bring to each of them that which they lack, just as they carry from one end of the country to the other the provisions, industrial products and the thousand and one things necessary for the daily life of the country. Thus, day after day, thousands of tons of goods are carried on the railway.

The SWISS FEDERAL RAILWAYS have 18 000 wagons available for this transport, 7 500 of which are reloaded every day. Every day 3 000 wagons are required for the parcels traffic, 300 for express parcels, 600 for livestock, 330 for milk, without counting 500 to 600 which have to be sent abroad to collect goods of vital importance. The distribution of this rolling stock and the whole organisation of the transport represents a work which cannot even be imagined by the uninitiated. Goods traffic is subject to considerable fluctuations every season and even from day to day. The SWISS FEDERAL RAILWAYS must be ready at all times to supply a maximum number of wagons. The war has still further increased their work. They carried 13 million tons in 1936. In 1942, this figure has increased to 23 million tons. The SWISS FEDERAL RAILWAYS have dealt with this extra traffic without any serious upsets. Thanks to the rationalisation measures, the rolling stock is utilised to the utmost limits. To speed up the turn round of vehicles, the time taken for loading and unloading the wagons in the stations has been shortened. Any interruption in the working of this huge transport undertaking would paralyze the whole economic life and culture of the country.

The

SWISS FEDERAL RAILWAYS

the patrimony of the people

Fig. 11.

THE SWISS FEDERAL RAILWAYS, THE LINK BETWEEN TOWN AND COUNTRY.

The Swiss Federal Railways span the gap between the productive country and the town, the consuming centre and economic and cultural heart. Every day, they take nearly 90 000 people to work or to school. They endeavour to shorten the journey times and the intervals between trains. They have introduced very cheap tickets, especially for workmen and scholars. The ordinary 3rd class fare is 7 centimes a kilometre. The traveller going to work, however, whether in town or country, thanks to the season ticket rate for given journeys, only pays 1.8 centime per kilometre. The scholar pays still less. Those who only travel occasionally to town, perhaps to go to the theatre or a concert, or to a course of lectures, can buy reduced fare tickets for 10 return journeys a month. The return fare for 10 kilometres costs not the 1 fr. 20 of an ordinary ticket but only 70 centimes, no more than a tram ticket. Out of 158 million passengers carried in 1942, more than 86 millions enjoyed reduced rates of some sort or other. Cheap tickets make it possible for the citizen to make many more excursions, which is to the advantage of the rural and mountain population. As an intermediary between town and country, the Federal Railways share in strengthening the unity of the Swiss people.

The

SWISS FEDERAL RAILWAYS

the patrimony of the people

Fig. 12.

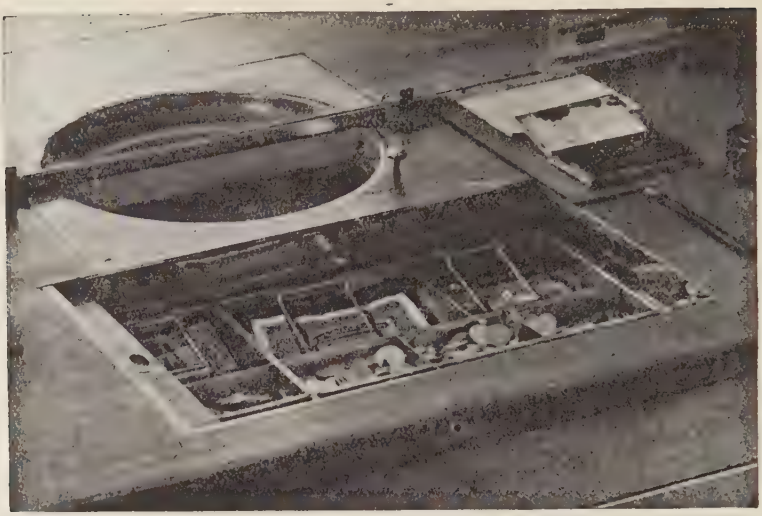


Photo 16. — Passenger booking office. Turntable for change and sliding till.

Photo 17. — Station office organised on lines laid down by the Planning Office of the General Management.

tionalisation of the undertaking is being carried out without pause in all fields, in order to perfect the services.

In spite of the results obtained, however, the future is not without grave preoccupations for the Railway Management. To meet the growing competition of other methods of transport, the Railways

must make the fullest use of all technical progress.

The new law on the Federal Railways imposes this obligation upon them (First Article). With this end in view, a vast programme of constructional and renewal work has become necessary. This programme is already in existence; it was drawn up in 1943, in connection with the plans made by the Authorities during the war period to deal with the possible unemployment problem at the end of the war (programme of work) and covers the following points :

	Millions of Swiss francs.
1. Doubling the track	246
2. New lines and renewal of lines .	32
3. Extension of station sidings and safety equipment	60
4. Enlarging and converting buildings	15
5. Altering and strengthening bridges	27
6. Suppressing level crossings . . .	26
7. Development of small tension low voltage installations	3
8. Extension of electrification . . .	51
9. Renewal of rolling stock	300
Total . .	760

This programme was to be carried out with the help of labour subsidies granted by the Confederation in order to prevent unemployment. As there was no unemployment problem, the subsidies were not granted. The programme of the Swiss Federal Railways, however, has to be carried out independently of the situation regarding labour. The chief difficulty is to finance it, especially in the case of points 1 and 9. The resources of the undertaking are insufficient for this. On the other hand, the electrification programme is practically completed, and part of the programme for doubling the track was carried out during the war.

For the rest, other methods of financing the work have to be sought, even if this increases the total endebtedness of the railways. It is to be hoped that the Authorities will prove sympathetic. The present traffic shows that the railways are still the most popular method of transport. More than ever they are the great public service with which neither the public nor the army can dispense, and without which the internal economy of Switzerland would have received a mortal blow during the war. We hope that this fact will be both appreciated and remembered.

[625 .144 (.73)]

Big special-trackwork job goes in smoothly,

by T. H. BEEBE,

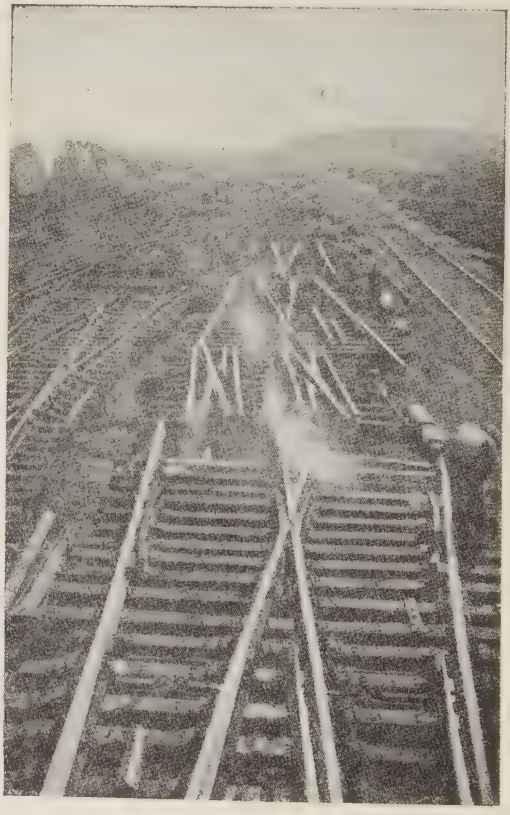
Chief Draftsman, Chicago & North Western.

(*Railway Engineering and Maintenance, November, 1946.*)

An interesting installation of preassembled special trackwork was made recently by the Chicago, Milwaukee, St. Paul & Pacific and the Chicago & North Western at the crossing of their main lines near Western avenue and Kinzie street in Chicago. This location is about three miles west of the respective passenger terminals of these roads, and is situated between these terminals on the one hand and the passenger-train yards and engine-terminal facilities of the two roads on the other, with the result that, in addition to the regular train movements, there are many backup and switching movements between the yards and the passenger stations.

All passenger trains of the Milwaukee, including its Hiawathas, pass over the crossing, as well as all through trains of the North Western to Omaha, Denver and the Pacific coast, including the Streamliners and the Challengers. In addition, both roads maintain a heavy suburban service between downtown Chicago and the western metropolitan area, resulting in peak movements over the crossing during the morning and evening hours. Although the traffic consists predominantly of passenger trains and passenger-train equipment, there are a considerable number of freight and interchange movements, participated in by the Pennsylvania, the Baltimore & Ohio, and the New York Central. The average number of movements over the crossing in a 24-hr. period is 650, of which about 500 are in the 13-hr. period between 6.00 a.m. and 7.00 p.m.

The crossing, which is at grade, consists primarily of a Milwaukee four-track system intersecting a North Western four-track system at an angle of 8 deg. 10 min. 16 sec. It includes the necessary double-slip switches, turnouts and crossovers to facilitate the



Some of the units of special trackwork, completely assembled in a yard about one-half mile from the crossing.

routing of trains by each road over any of its tracks; for complete interchange facilities; and, in the case of the North Western, for handling movements in and out of the eastern end of its California Avenue coach yard, immediately west of the crossing, for turning movements on the east end of its Rockwell Street wye, also west of the crossing, and for a minor portion of freight movements to and from the industrial and interchange district on the south and south-west sides of Chicago.

An old, out-of-service steel truss foot bridge was used as the stiffening member in moving each unit from assembly point to point of installation.

The present track arrangement was installed a little over forty years ago. In the recent project, the trackage replaced consisted of 100-lb. rail, section 10 035, which was installed in 1925, thus having a service life of 21 years. It is interesting to note that the 90-lb. material that was in service prior to 1925 was in place 20 years.

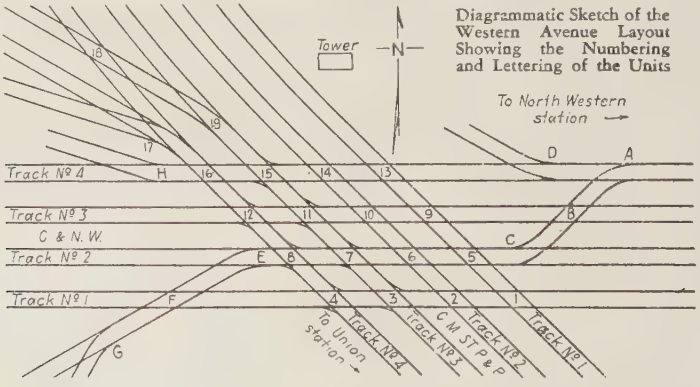
Preliminary planning.

Tentative plans for the renewal of the special trackwork at the Western Avenue crossing were made by representatives of the engineering departments of the North Western and the Milwaukee some eighteen months ago. A joint engineering survey was made of the existing track layout, and a large-scale plan was prepared. Based on a study of this plan, the decision was reached to preserve the original alinement of both roads on 13-ft. track centers, with certain exceptions. The alinement was made tangent through the crossing except for certain portions of the Milwaukee's freight mains (Tracks No. 3 and No. 4), which are on 12-deg. 30 min. curves through five units, two of which are double slips. The track centers of these mains at the westerly end of the plant were changed from 13 ft. to 15 ft., which required a curvature of 3 deg. 11 min. through a rigid-frog crossing. Another decision was to use the Milwaukee's rail section (13 128) for all of the trackwork, except for one No. 10 double-slip switch and four turnouts, exclusively in C. & N. W. trackage, where the 11 228 rail section was used.

In the crossing system proper there are 19 units, consisting of 8 No. 7 movable-point crossings, 7 No. 7 double-slip switches, 2 rigid frog crossings, a lap turnout (No. 17 on the diagram) and a

special turnout with leads curving in opposite directions, not equilateral (No. 19). In addition, the North Western renewed a No. 7 double-slip switch and 2 No. 7 turnouts with 13 128 material. Of the 27 units enumerated, the established alinement, and the dimensions computed carefully. A number of improvements were incorporated in the design of the No. 7 double-slip switches, including a uniform curvature of 11 deg. 2 min.

Picking up a completely-assembled double-slip switch and setting it on two flat cars for movement to point of installation.



the Milwaukee maintains 4 No. 7 movable-point crossings, and the North Western the remainder, 10 at its own expense and 13 at joint expense.

Trackwork improvements.

Plans were prepared on the basis of between the points of switches, compared with 15 deg. in existing plans. Also, the gage was widened to 4 ft. $8^{7}/_{8}$ in. between points of switches, and the angle at the point of switch was reduced to 1 deg. 18 min. by the use of 14 ft. curved points, which are housed

to maintain a uniform gage line, with a heel spread of $6^3/_8$ in. on the straight side and $6^5/_8$ in. on the curved side. All switches are of the Samson type with under-cut stock rails, and the switch rods in all switches and movable-point assemblies are type M and type MF vertical rods. The movable center points were designed to be used interchangeably in the double-slip switches and in the movable-point crossings. The present brace-rail assemblies were designed by the manufacturer to bind insulated joints in computing rail lengths. New switch machines were furnished and installed on each unit as it was assembled, and upon completion of the assembly, but prior to installation, the operation of the machines was thoroughly tested.

Decide on pre-assembly.

In view of the difficult problem posed by the heavy traffic moving over the

As soon as old slip was out, the old tie bed was cut down about four inches, using hand picks and Barco power hammers.

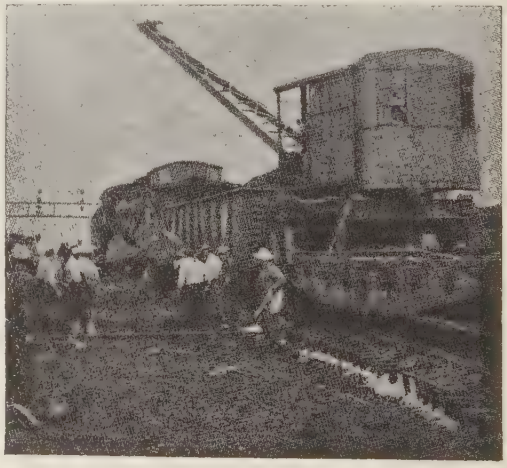
the movable points and the knuckle rails together as a unit and to control creepage of the parts, improving the usual anchorage device. To reduce curvature and lead lengths and to provide interchangeable material, the 14-ft. curved switch design was also used in seven turnout units.

Because of the many routes involved, a large number of insulated joints was required, the locations of which were carefully established by the signal departments of the two roads with the objective of keeping the dead space in track circuits to a minimum. Allowance was made for the end posts of the crossing, joint meetings were held by the operating and engineering officers of the two roads to determine a method of installation and a procedure which would minimize traffic delays. As a result it was decided to completely assemble the units out of track at convenient locations close to the crossing. A schedule was prepared covering the installation of the 27 units in 25 consecutive days. A diagrammatic plan of the crossing was prepared, on which each of the Milwaukee and joint units was identified by number and the North Western units by letter. A white print of this plan was then made and colored

Lifting out old double slip, one third at a time, and stacking the units on a flat car for removal.

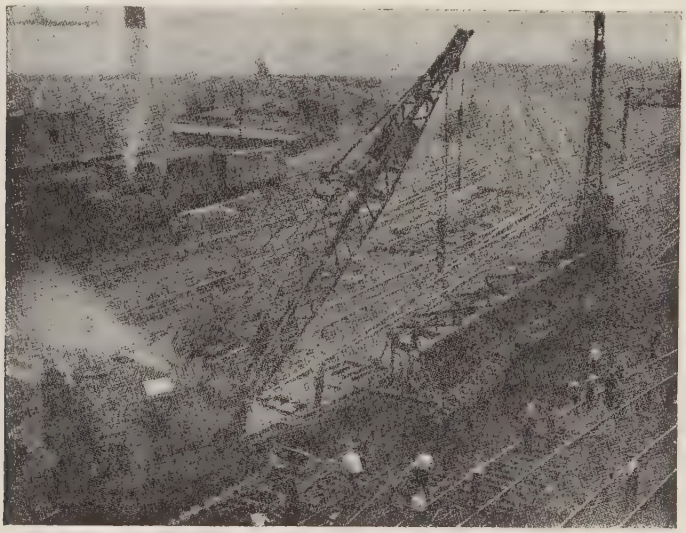
for each of the 25 days' operations. On each day's plan the unit to be placed on that day was colored in red — meaning that the trackage involved was out of service — and the adjacent trackage which would be temporarily used at intervals by work trains was colored yellow. Copies of these plans were furnished to the operating departments for their use in re-routing traffic and to the engineering officers in charge of the field work. On two of the days the Milwaukee and the North Western each placed a unit in the same track.

The Milwaukee's four units were assembled in a yard that this company has northwest of the site, and the North Western assembled 18 units in a yard it has approximately 1 000 ft. west of the site. The remaining five North Western units were assembled in available space immediately adjacent to their final locations. Each unit was completely assembled on 7-in. by 9-in. creosoted ties, with all plates, switch rods, switch machines, joint bars and bonding in place, so that when a unit was set in final position the only remaining steps required were to make the end connections, and connect the control wires and air to the electro-pneumatic switch machines. In assembling the double-slip and movable-point, the knuckle rails were lined with a transit to insure that the center of each knuckle would be at right angles to the long diagonal of the unit. This was necessary because all of the units were designed and fabricated to make direct connections with adjacent units, and any variation would adversely affect the joint-gap allowance. In assembling the curved crossings and all of the turn-outs, the theoretical curvature was established by transit to avoid irregularity of alinement when installation was made. Through careful instrument work, no difficulty was experienced in making connections with new units, even though in some cases it was necessary to place a new unit between new units previously installed.



Assembled in piles, the old ballast was loaded out with a Burro crane equipped with a Clamshell bucket.

To make certain that there would be no distortion of the assembled units in handling from the point of assembly to the final position in the track, and to enable the assembled units to be accurately placed with no temporary blocking between the bottoms of the ties and the tie bed, a special method of handling the units was devised which fulfilled both of these conditions. As one of the assembled No. 7 double-slip units, complete with switch machines and ties, was 82 ft. long, exclusive of the attached stock rails, and weighed 42 tons, a rigid lifting arrangement of considerable length was needed. To meet this requirement a secondhand riveted span, consisting of two trusses 6 ft. in depth, 86 ft. in length, and spaced 5 ft. 6 in. center to center, with reinforced cross connections, was used.



Two Brownhoist cranes setting a new double slip as a unit on the newly-prepared tie bed.

The lifting arrangement.

In arranging the lifting device, a number of switch ties were placed transversely on top of the unit to be handled and the truss frame was set on top of these. The switch ties were spaced 13 ft. 10 in. apart, being placed to fall under alternate panel points of the truss frame. A temporary supporting rail was then placed transversely under the unit rails between the ties at the location of each of these switch ties, and the truss was attached to the unit by wrapping a heavy chain around each of the supporting rails and the bottom chord and floor beam above it. The slack was taken out of the chains with wood wedges. Each unit was lifted by a locomotive crane at each end, attachment being made to the top chords by the conventional bridle to hold the unit level, and was loaded on two empty flat cars placed between the cranes. The unloading was a reverse procedure after movement to the point of installation by work train. This part of the work was handled by a steel bridge erection crew.

The sequence of each day's work was as follows:

(1) Final cleaning of the cribs of the

unit to be changed was carried out by a track crew of approximately thirty men, starting at 7.00 a.m.

(2) At 8.30 a.m., or somewhat later, the track involved was turned over by the operating department, at which time the old unit was cut into three sections with oxy-acetylene torches, and a work train, including a locomotive crane and an empty flat car, was moved in on an adjacent track and the cut sections loaded. This operation usually consumed about fifteen minutes.

(3) The old tie bed was broken up with hand picks and mechanical tampers equipped with bull points, and was excavated to a depth of four inches below the bottoms of the old ties. The excavated material was temporarily piled wherever it would not interfere with traffic. This operation consumed considerable time, due to the limited number of men who could be worked in the area and the hard compaction of the old tie bed, being completed usually between 12.00 and 12.30 p.m. At the same time, the ends of any of the old ties which would interfere with the placing of the new unit were sawed off with a power chain saw.

Setting the new units.

(4) The new unit, loaded as stated on two flat cars between two locomotive cranes, was brought up by work train and set in place to accurate location determined by transit. This operation consumed 25 to 30 min., a considerable part of this time being used in getting the unit accurately placed.

In place, the new double slip is being coupled up, while the signal forces hook up the electro-pneumatic switch machines.

(5) The end track connections were made, along with the signal and air connections to the new unit. Short batter connecting rails were furnished with the units for connections to the old 10 035 rail sections, and these, together with the standard compromise and insulated joints needed, were brought in fastened temporarily to the unit ties. The use of batter rails was desirable to permit the installation of

insulated joints in their final location, and in all cases the old rail was cut back to permit their insertion. This practice eliminated any cutting of the new rail. Power rail drills and power bonding drills were used where necessary in making the connections. This phase of the work usually consumed from 30 to 40 min.

(6) New stone ballast, along with a Burro crane mounted on a flat car for unloading it, was brought up by work train, and sufficient ballast for temporary surfacing was unloaded on the unit, which was then raised and tamped to surface, and the track restored to service between 4.00 and 5.30 p.m.

(7) Track forces cribbed out the old unit to be replaced the following day, and bridge forces fastened the lifting arrangement in place on the next new unit to be installed.

The old ballast was loaded at opportune times by locomotive crane or by casting it over the retaining wall into trucks on the street below, this being Western avenue which is carried under the tracks in an underpass.

Use of a Buda power drill speeded rail drilling for connections with old rails.

Completed on schedule.

The work was started on schedule on August 4 and was completed on schedule on August 28. One day was lost unavoidably by reasons having no relation to the project, but this was later made up by the installation of two adjacent units on the same day. The assembly, installation and initial surfacing of the 27 units required 36 413 man-hours of work with no accidents other than one reportedly sprained back.

The final surfacing is still in progress, and it is planned to install rail and flange lubricators on the tracks approaching the crossing in order to reduce wear on the curved portions of the double-slip switches and turnouts.

Personnel.

The plans for the special trackwork were prepared by the author and

A. F. Huber, chief engineer, Ramapo Ajax Division, American Brake Shoe Company, under the supervision of C. T. Jackson, assistant chief engineer of the Milwaukee, and E. C. Vandenburgh, then engineer of maintenance of the North Western, and now chief engineer. The units were fabricated by the Ramapo Ajax Division in accordance with final detail drawings prepared by its engineering department.

The plans for installing the units were prepared by G. A. Saint, assistant engineer of the North Western, who followed this phase throughout the progress of the work. The installation work was supervised by T. H. Strate, division engineer, and D. H. Herlihy, roadmaster, both of Milwaukee, and P. V. Thelander, division engineer, and J. E. Wilkinson, roadmaster, both of the North Western. The signal and interlocking work was supervised by M. H. Schmidt, supervisor telegraph and signals of the Milwaukee. The work was carried out under generally favorable weather conditions. No difficulty was experienced with misfit material and no unforeseen difficulties interfered with the orderly procedure as planned.

A part of the Western Avenue crossing, showing two of the new double-slip switches in the foreground.

[625 .144 .4 (.73)]

This new ballast cleaner is different.

(Railway Age, September 14, 1946.)

The Atchison, Topeka & Santa Fe has developed and now has in successful operation a ballast cleaner of unusually large capacity, which incorporates a new principle in the design of such equipment. The machine is of the on-track type and is designed to clean the shoulder ballast and that in the intertrack space in double-track territory. It is expected that, fully perfected and operated throughout the year in accordance with a definite program or cycle designed to prevent the ballast from becoming excessively foul, the machine will be capable of cleaning the ballast on about 1 250 miles of track annually.

The ballast cleaner in action, drawn by a locomotive operating in reverse.

The new ballast cleaner is mounted on a specially-designed all-steel car of heavy construction and is drawn by a locomotive when in operation, being pulled at a speed of 2 to 2.5 miles an hour, depending somewhat on the condition of the ballast. The major operations involved in cleaning ballast are performed by and within two giant revolving wheels, one on each side of the car, which incorporate means for picking up the ballast, cleaning it, returning it to the track shoulder and wasting the dirt. The wheels are each mounted in a heavy structural-steel frame, which in turn is attached to the car in such a manner that it can be moved to and from the operating position and adjusted as necessary to accommodate the machine to changes in the ballast section. The two wheels are provided with separate drives and controls, and are, therefore, entirely independent of each other. They are mounted on the sides of the car somewhat back of the center, leaving the forward end available for the driving engines, the operator's platforms and other auxiliary features.

How wheels operate.

Each wheel frame is attached to the car by means of pantagraph arms so that, in being moved between the raised and lowered positions, the frame remains always in a vertical position. When the machine is not in use the wheel frames are folded back into the sides of the car; to place them in the operating position they are moved outward and downward as necessary. These movements of each wheel frame are accomplished by two 19-in. air cylinders, one at each end, which are used in conjunction with two 8-in. hydraulic cylinders for holding and locking the wheel frames in any desired intermediate position.

Each of the ballast wheels has a diameter of 12.5 ft., and is in reality a revolving rim, designed to pick up the ballast from the shoulder or the intertrack space and dump it over three banks of screening grizzlies located inside the rim in a fixed position. To accomplish this purpose each wheel consists of a series of steel buckets mounted between circular steel plates that form the side rims of the wheel, these plates being 36 in. apart. Each wheel is supported in its frame and rotates on a number of rollers fixed to the frame inside the wheel.

When the ballast-cleaning machine is in operation the wheels rotate at a constant rate of 10.5 r. p. m., the direction of rotation being clockwise to a person standing beside the track with his left side toward the forward end. The buckets in the periphery of the wheel are so designed and positioned that the ballast picked up by them is dumped inside the wheel as they pass through the upper lefthand quadrant of rotation. As it leaves the buckets the ballast is thrown onto the three banks of grizzlies or bar screens, which are mounted inside the wheel in an inclined position descending toward the rear of the machine, the angle of the incline being 30 deg. with the horizontal. In each bank of grizzlies, there are a number of separate grizzlies, with the lower end of each unit placed several inches above the upper end of the one below it.

The design of the wheel and the rate of rotation are such that, as the ballast leaves the buckets, it is thrown against the grizzlies with considerable force, and, since succeeding grizzlies in each bank are offset from each other by several inches, the particles of ballast are subjected to successive jarring movements as they pass over the grizzlies.

Forward end of one of the wheel frames. Note how ballast is piled in windrows by plow.

The agitation of the ballast thus produced is such as to separate effectively from the particles any dirt clinging to them. As the ballast particles leave the grizzlies their direction of movement is downward and toward the rear, where they pass out of the wheel through spaces between the buckets.

Mounted in the lower rear portion of each wheel frame is a series of baffle plates by means of which the cleaned ballast is kicked downward in a lateral direction (toward the track) to the track shoulder. Other baffle plates suspended from the wheel frame at approximately the ends of the ties deflect down-

ward ballast that otherwise would be deposited on the ties. Any ballast remaining on the ties is brushed off onto the shoulder by a wiper blade placed directly behind the ballast wheel and frame. By means of the several sets of baffle plates and the wiper blade, the ballast is returned to its proper position and slope in the track shoulder and no further shaping is required.

Dirt disposal.

The dirt and other foreign matter that is separated from the ballast as it moves over the grizzlies drops downward between the bars of these parts. Underneath each of the upper two banks of grizzlies is a metal deflector plate,

Rear end of wheel frame showing baffle plates for keeping ballast off ties and tie-wiper blade (extreme right).

by means of which foreign matter coming through the grizzlies is deflected sideways, falling downward in the spaces between the grizzlies and the sides of the frame.

The dirt coming from the deflector plates underneath the two upper banks of grizzlies, and that falling directly through the lower bank, lands on an endless conveyor belt 42 in. wide near the bottom of the wheel, by means of which it is thrown outward onto the right of way. For use in double-track territory a conveyor extension, 14 ft. long, is carried on the machine, which is attached to the short conveyor in the ballast wheel on the inter-track side of the machine.

Pick-up blade.

Directly beneath each ballast wheel is a transverse scoop or pick-up blade mounted between two longitudinal plates attached to the lower sides of the frame, these plates being 37½ in. apart. The pick-up blade is a heavy plate with its bottom edge on a slope of 1 to 9 downward away from the track, this being the standard subgrade slope on the Santa Fe. As the blade moves forward the ballast piles up ahead of it between the side plates and is raised sufficiently so that it can be picked up by the elevator wheel.

When the machine is operating in single-track territory the lower parts of both wheel frames remain as described above. For operation in double-track territory it is necessary to make a slight adjustment in the pick-up blade on the intertrack side of the machine, which consists of attaching an extension member to the blade, of such dimensions that the cutting edge is lowered six inches, retaining the same transverse slope. The purpose of using the extension blade is to make it unnecessary for the outer side plate to be forced into the inter-track ballast in obtaining a cut of the desired depth. Also, whereas the regular pick-up blade is about 36 in. wide, the extension blade is only 27 in. in width and is fastened in place so that its inner end is even with the corresponding end of the regular blade. Thus, the overlap that occurs in the inter-track space when the machine is operated from both tracks is only about 3 in.

Scarifier and plow.

In advance of the ballast wheel on each side of the car are provided two devices by means of which the ballast

is loosened and shaped to prepare it for being picked up by the elevator wheel. The foremost of these is a heavy, vertical scarifier tooth placed just beyond the ends of the ties, which is raised and lowered within a heavy guide housing by means of an air cylinder overhead. The purpose of the scarifier tooth is to make a preliminary break in the ballast and to remove any foreign objects that might interfere with the operation of the ballast-cleaning mechanism.

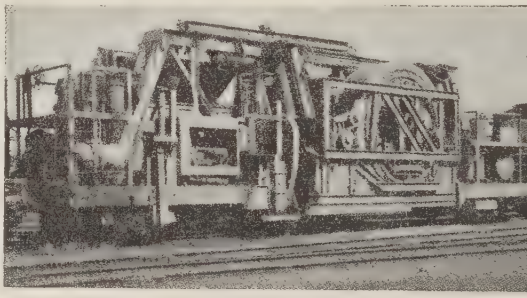
Behind the scarifier tooth is the second device for preparing the ballast. This is a plow which, with its forward end operating in the path formed by the scarifier tooth, forces the ballast outward away from the ties into a windrow of the proper width to be encompassed by the bottom side plates of the wheel frame. A stop extending from the sideframe of the car prevents the plow from moving closer to the track than the end of a 9-ft. tie, which is the longest tie used on the Santa Fe.

How wheels are driven.

As already indicated, each wheel is powered by a separate engine. These engines, which are mounted on the forward end of the car, one on each side, directly ahead of the respective ballast wheels, are both 135-hp. gasoline engines. The power take-off from each engine terminates in a herringbone speed reducer, the shaft of which is connected with the shaft of a miter box on the wheel frame by a roller-chain drive. The power is transmitted through the miter gears to two sprocket wheels, one on each side of the box. From these sprockets the elevator wheel is driven by two roller chains of the type used in drilling oil wells, one operating on each of the sprocket wheels and on a set of sprocket teeth extending around the side rim of the wheel.

The rotation of each elevator wheel is used to furnish power for the operation of the conveyor belt inside the wheel for disposing of waste material. This is accomplished by means of a set of internal gear teeth mounted on the outer side plate of the wheel. A sprocket wheel operating on these gear teeth drives the conveyor belt through a miter box.

The operation and all movements of each elevator wheel and its frame are controlled from an operator's platform situated directly ahead of the wheel in a slightly elevated position, where



The machine with wheel frames in retracted position.

the operator has a clear view of the forward end of the frame and where his signals can be clearly seen by the crew of the pulling locomotive, which is coupled directly to the machine and which operates in reverse.

Auxiliary features of the ballast cleaner include a gasoline-driven compressor of 160 cu. ft. capacity, a gasoline-driven arc-welding generator, a pneumatic greasing system, a gasoline storage tank of 360 gal. capacity, and an oxy-acetylene cutting and welding outfit.

Operating personnel.

The ballast cleaner and its crew are under the direct supervision of a track supervisor who devotes all his time to this work, living with the outfit. The

crew for operating the ballast cleaner (exclusive of the train and engine crews) is composed of two operators and two assistant operators. Frequently several section laborers are included in the crew to remove foreign objects from the ballast ahead of the elevator wheels. Also, the outfit is accompanied at all times by a welder.

Plans for operation.

The program that has been worked out on the Santa Fe for the operation of the ballast cleaner contemplates that it will be assigned to the Western Lines of the road for the major part of each year. Much of this territory is located in so-called dust-bowl country where ballast is fouled relatively rapidly by fine wind-borne material which is deposited primarily in the ballast shoulders. There are 1 950 miles of track in this territory ballasted with crushed stone or slag, and it is planned to go over all of this mileage with the ballast cleaner every two years, cleaning half of it or 975 miles, in alternate years. It is estimated that the aggregate savings to be realized by this program through lower track maintenance costs generally will amount to many times the cost of cleaning.

It is expected that the machine will be used about nine months of the year on the Western Lines, and that during the winter months it will be assigned to the Coast Lines and the Gulf, Colorado & Santa Fe. During the three-month winter period the machine will be given a general over-hauling, estimated to require about two weeks, while about another two weeks will be spent en route in commercial trains.

The machine has now been in operation about a year, and during this period it has been necessary, in order to obtain ballast of the desired cleanliness, to make two passes over about one-quarter of the mileage oovered, the territory requiring recleaning being nearly all in double-track territory, with one pass sufficing for the remainder. In the future, when the ballast is cleaned on a two-year cycle, it is expected that one pass will be sufficient in all cases. On this basis, and with the machine fully-developed and working an eight-hour day, it is estimated that an average of 5.5 miles of track will be cleaned daily, allowing for delays occasioned in clearing trains.

The Santa Fe's ballast cleaner was designed under the general supervision of G. W. Harris, chief engineer, by T. A. Blair, assistant chief engineer, assisted by John R. Rushmer, roadway engineer. The machine was built by the O. F. Jordan Company, East Chicago, Ind.

[656 .254 (.73)]

Carryphone in service on Pennsylvania,

by W. R. TRIEM,

General Superintendent of Telegraph Pennsylvania Railroad.

(Railway Age, November 9, 1946).

Rounding out its inductive train communication system perfected after years of cooperative activity with the Union Switch & Signal Company, the Pennsylvania recently placed in service a portable unit called the carryphone.

The carryphone is a portable inductive telephone set for use of trainmen and other employees, primarily as an adjunct of the inductive trainphone system which is now in regular use between Trenton, N. J., and Phillipsburg, N. J., on the Belvidere Branch of the New York Division, and between Harrisburg, Pa., and Pittsburgh, Pa., on the Middle and Pittsburgh Divisions of the Pennsylvania. This new telephone apparatus, similar in many respects to a « walkie-talkie », but employing induction instead of space radio, is also suitable for many purposes not involving use of the existing train communication systems. It is expected to be found valuable on wreck trains and work trains where the operation of derricks and machines of various kinds must be coordinated and directed from one location on the ground, as well as in many other fields of railroad operations.

A Pennsylvania freight conductor uses the new « carryphone » portable telephone to keep in touch with his engineman while making a routine inspection of his train. The « carryphone » operates in conjunction with the inductive train telephone system installed by the Pennsylvania on 1 056 miles of main tracks between Harrisburg and Pittsburgh, and on the Belvidere-Delaware branch in Northern New Jersey.

In the *Railway Age,* February 12,

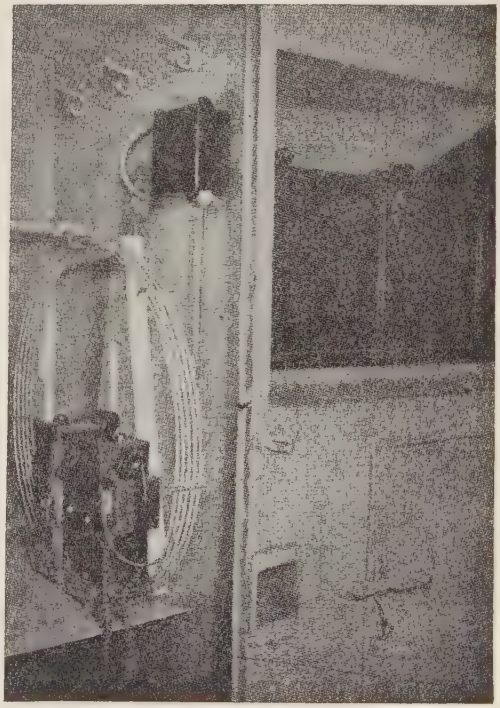
1944, progress in development of an inductive train telephone system then on trial on the Belvidere Branch of the Pennsylvania was described. At that time, joint development and experimentation in the field of train communication by the Pennsylvania and the Union Switch & Signal Company, had produced a workable inductive telephone system, employing 5 700-cycle current and amplitude modulation. Later in the same year, trials of a system employing 88-kilocycle and 144-kilocycle frequencies, with frequency modulation, warranted its adoption in place of the earlier one. Trials and development work on the branch line with the new scheme have continued, and together with the large-scale experiment on the four-track main line of the Pennsylvania, between Harrisburg and Pittsburgh, has produced a train communication system satisfactorily meeting railroad requirements. Today, about 300 locomotives, 100 cabin cars and 16 wayside stations are in regular service on 1 056 miles of main tracks.

The carryphone embodies features of the parent system, and operates on 88 kilocycles, one of the frequencies of this two-frequency system. Just as the inductor loop on the locomotive and cabin car creates a magnetic field, inducing currents in adjacent wire lines and tracks, so does a small 30-in. loop on the carryphone perform the same functions on a smaller scale. In like manner, the receivers on the locomotives and cabin cars are provided in miniature in the carryphone.

Features of design.

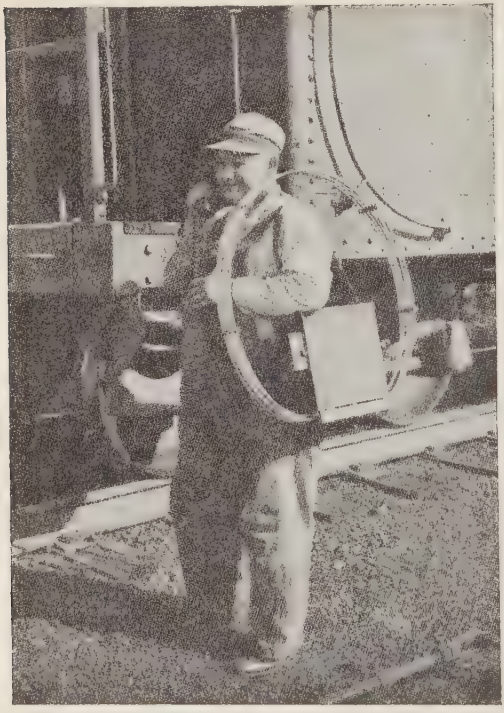
Details of design of the carryphone are : cabinet, size—16½ in. long, 12¾ in. high, 4⅞ in. wide. Inductive loop—5 turns, ¼-in. tubing, 30 in. in diameter. Weight—29 lb. Power—Two storage batteries : 6 volts and 2 volts. Capacity—45 minutes' transmission, or 6 hours' reception; approximately 2 hours' ordinary service. Transmitter output—2.5 watts. Telephone—Handset with «push-to-talk» button. Volume control—Automatic. Range—carryphone to carryphone or train—2 to 3 miles. Carryphone to wayside station—10 to 15 miles.

The carryphone apparatus is installed in the cabin car for the use of the train crew. When placed in the receptacle provided for it, the batteries of the carryphone are automatically connected with the batteries serving the larger train-phone systems; thus, the carryphone is always charged and ready for service.



The « carryphone » in place in a Pennsylvania cabin car. When resting in the special receptacle prepared for it, its tiny storage batteries are automatically connected with the larger batteries of the cabin car train telephone unit, and are kept fully charged. Lifted out of the receptacles, it is ready for independent use.

The operation of the carryphone is in no wise dependent upon the trainphone apparatus on adjacent cabin cars and locomotives. It works as an independent unit of the trainphone system; in fact, an employee with a carryphone may drop off of a train anywhere, and while the train proceeds on its way, he may communicate with wayside stations and his train and other trains in his vicinity.



The new « carryphone », weighing about 29 lb., has a range of up to three miles when used to communicate with another « carryphone » or with a train equipped with the train telephone, and of up to 15 miles when used to call a wayside control tower. The loop, consisting of five turns of $\frac{1}{4}$ inch metal, is 30 in. in diameter and provides means by which messages are received and transmitted by induction, using the track and wayside pole lines as channels.

The carryphone is suspended at the side of the operator by a shoulder strap, the telephone hand-set being thus readily removed and replaced while walking or standing. To use it, all that is necessary to establish contact with a station is to remove the telephone hand-set from the side of the cabinet and broadcast the name of the station called. When the station responds, telephone conversation is conducted by the push-to-talk method, similar to the trainphone on trains. Carryphone works satisfactorily at distances up to about 100 feet from pole lines.

A convenient tool.

Train crews find the carryphone to be a convenient tool, and use it frequently. For example, a hot box on a car in the middle of a train having been reported to the conductor and engineman of a train by trainphone, it was agreed between them on the trainphone that the train should be stopped at once, and the conductor make an inspection. The conductor taking the carryphone with him, found the condition of the journal such as to require the car te be set off, and so advised the engineman directly on the carryphone. The car was set off, train reassembled, and it was able to proceed without delays which otherwise would have been incurred without this newest method of communication.

A number of instances have occurred where the conductor of a freight train, after conversation on the trainphone system with the engineman of his train and wayside station, or with other trains in the vicinity, has found the carryphone to be of great assistance in taking care of unusual conditions. The delays resulting from unforeseen adverse circumstances or unusual conditions are minimized by its use in planning and carrying out work involved.

[656 .254 (.73)]

Radio in railroad tunnels.

(The Railway Mechanical Engineer, October, 1946.)

A newly devised system for transmitting train radio signals through long railroad tunnels has been demonstrated by Bendix Radio Division of Bendix Aviation Corporation in collaboration with the Baltimore & Ohio.

Railroad tunnels have been considered « dead spots » in train radio communications, but the tests on the Baltimore & Ohio show that trains using VHF space radio can carry on satisfactory continuous end-to-end and train-to-wayside communication while the train is passing through long tunnels. The designers state that simple means have been found to overcome tunnel wall absorption of radio energy and a consequent drop of signal strength over appreciable distances.

The tunnel radio installation was made in a half-mile-long tunnel on the Baltimore & Ohio's main east west freight line at Mt. Airy, Md. For the demonstration, Bendix MRT-1B VHF railroad communication units and associated equipment were installed in a baggage car and a caboose of a local freight train. The train was first backed through the 2 760 ft. tunnel, and then made a return trip on the adjacent tracks. Continuous communication was maintained between the forward and rear end of the train, and at no time was there a drop in audio signal. Without the new transmission system, radio signals fall below a commercial level at distances of approximately 300 ft., in tunnel operation.

In the Mt. Airy demonstration, high-gain rhombic antennas were located atop a hill at both entrances to the tunnel. These collector antennas, which « look » down the tracks, are linked with six strands of copper wire running through the tunnel near the crown. Ten inches below, this shielding network, which is three feet wide, is suspended a single insulated wire. The latter carries and re-radiates the radio signal within the tunnel.

Experiments conducted from fixed points outside, revealed that when the transmitter was operated approximately one mile from the tunnel mouth, signal strength within the tunnel compared favorably with free space transmission. The same was true of calls originating within the tunnel to points outside. Readings obtained showed that the transmission line attenuation in the Mt. Airy installation was 15½ db., and that there was a 30 db. drop from line to train. This was offset, however, by the 15 db. gain inherent in the rhombic antennas and by the additional gain secured by locating the collector antennas on the hillside approximately 50 ft. above the roadbed. The system is designed to give a commercial signal with a drop of up to 141 db. between transmitter and receiver in tunnel communication.

The demonstration at Mt. Airy was conducted at an operating frequency of 158.19 megacycles. Throughout the entire time that the train was approaching and passing through the tunnel, a running conversation was maintained be-

tween an operator in the baggage car, immediately behind the steam locomotive and tender, and an operator in the caboose at the rear of the train. The position of the train at any particular time had no noticeable effect on signal strength.

The demonstration was witnessed by A. S. Hunt, chief engineer communications and signals, Baltimore & Ohio, and L. J. Prendergast, superintendent of communications, Baltimore & Ohio, under whose supervision the installation at Mt. Airy was made.

[621 .138 (.42) & 621 .32 (.42)

Lighting « Trolley » for enginehouses.

(The Railway Mechanical Engineer, October 1946.)

The London Midland & Scottish Railway in Great Britain is systematically overhauling its enginehouse lighting and in the process has developed portable lighting units which suggest means for improving American practices. The relighting program employs three separate forms of lighting, namely, lighting from above, from the side, and from pits. As engine sheds fall due for re-roofing or rebuilding, opportunity is taken to install general overhead lighting, making use of 150-watt incandescent lamps in dust-tight cast-iron enamelled reflectors fitted with hinged glazed covers. The lighting unit is large enough to take a 200-watt lamp, if necessary, and the lamps are connected alternately so that half of them can be switched off.

Inspection and repair work on locomotives necessitates good lighting from the side. Neither the old fashioned « duck » lamp nor the electric hand lamp wired for 40 or 50 volts has proved adequate as a means of supplementary lighting and a « wheeled lighting trolley » has been developed to meet this requirement. This mobile unit consists of a welded tubular structure on rubber-tired castors, and on it are mounted two 80-watt fluorescent tubular « daylight » lamps, 5 ft. long, which give almost sha-

The framework is mounted on rubber-tired castors and is fitted with two fluorescent lamps, a receptacle for hand portables and a tray for tools.

dowless lighting. The tubes are mounted horizontally, and the upper one, with its reflector, is on counter-balanced arms which allow it to be set at any level between 5 ft. 6 in. above the floor. In the lowest position it lights the outside motion work of the locomotive while in the uppermost position it can light the inside motion on locomotives which are so equipped. The lower tube and its reflector direct light to the underside of the motion work, thus giving some of the advantages of pit lighting in locations where this is not provided. The fluorescent lamps operate at 200 volts, but the trolley can be fitted with a step-up transformer to take current from 50-volt handlamp receptacles. Of necessity the trolley is made rather narrow, the spaces through which it must pass being limited to that between columns and locomotives in straight sheds. The trolley has a tool tray and a socket for a hand lamp to be used inside fireboxes, etc.

Underneath lighting, such as that required in inspection pits, has been supplied hitherto from filament lamps, but in future the L. M. S. R. will use fluorescent lamps. The tubes, 5 ft. long, with their auxiliary gear, are housed in a cast-iron water-tight unit, which fits into recesses in the pre-cast concrete walls of the pit. The lighting units are not mounted opposite each other, but are staggered to insure greater uniformity of illumination. The lamp housing is glazed with armor-plate glass. As the housing protrudes only $\frac{3}{4}$ in. into the pit, it causes no obstruction, and it is not likely to be damaged.

[625 .143 .1 (.73)]

A.R.E.A. adopts three new rail designs.

(*Railway Age, November 9, 1946.*)

Under the sponsorship of its Committee on Rail, the American Railway Engineering Association has adopted three new rail sections—115-lb. RE, 132-lb. RE and 133-lb. RE, to replace its present 112-lb. RE and 131-lb. RE sections. It has also adopted joint bar designs for each of the new sections. The action with regard to both the rail and joint bars had been stepped up by resorting to letter ballot of the membership to permit 1947 deliveries, and the new designs were approved by the vice-president, operation and maintenance, Association of American Railroads, on October 19.

Each of the new sections has outstanding features of merit in itself, but equally, if not more important, is the fact that in their development they mark a new period in rail design, having been the result of a new technique in rail study, begun in 1940, when the late Dr. A. N. Talbot, University of Illinois, arranged for the use of carbon-strip gages in the measurement of the vertical components of the stresses in the webs of 112-lb. rail on the Denver & Rio Grande Western over gage distances as short as one-half inch. The development of these small gages and the subsequent introduction of the minute wire resistance gages made it possible to undertake detailed stress surveys of rails under load, and thus provided an entirely new fund of information concerning the behaviour of each in service.

Two sections replace one.

The new rail designs are based on both field and laboratory investigations carried out by the research staff of the Engineering division, A. A. R., and the test department of the Pennsylvania railroad, that provided a mass of reliable information beyond anything previously available in the study of rail design.

The new 115-lb. section supersedes the 112-lb. section of the Association, which has been withdrawn from its Manual of Recommended Practice. The former 131-lb. section has also been withdrawn from the Manual, and is superseded by the new 132 an 133 lb. sections. In submitting the two new latter sections for adoption in place of the existing 131-lb. section, it was recognized that a departure was being made from an established policy of offering only a single section of given weight for one being superseded, but because a considerable number of heavy-traffic roads desired a rail having a deeper head than the proposed 132-lb. section, it was decided that both the 132-lb. and the 133-lb. sections should be made available.

The 132-Lb. section.

The last three reports of the Rail committee have included studies relating to the form and dimensions of the webs of the 112-lb. RE and 131-lb. RE rail sections, as the result largely of the fact that stress measurements made several years ago revealed the occasional occurrence of high localized stresses in the upper part of the web and the upper fillets, particularly on the gage side, which were accounted for by eccentric loading of the rail when the wheel bearing comes near the gage corner. In the

ensuing investigation, extensive stress measurements were made in the field to determine the frequency of these high stresses with relation to the amount of traffic carried; laboratory tests were made to determine the fatigue strength of the steel in the rail web; and stress measurements were made with rails having various modified web designs to determine the extent that localized web and fillet stresses could be lowered by changes in design.

As a result of this investigation, the rail design show in Fig. 1, weighing 114.7 lb. per yd. was recommended by the Rail committee to replace the present 112-lb. RE section, the new section having the general proportions of the present 112-lb. RE rail, with the same overall height and base width of $6^{5}/_{8}$ in. and $5\frac{1}{2}$ in., respectively, these proportions being considered to be efficient with respect to flexural bending strength and stiffness. Neither test measurements nor service performance indicated that a revision of general proportions was desirable.

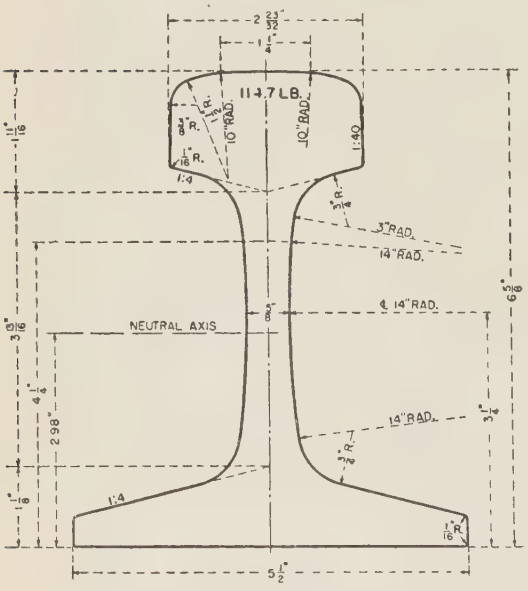


Fig. 1. — New 115-lb. RE rail section.

	Area Sq. In.	*Per cent.*
Head	3.91	34.8
Web	3.05	27.1
Base	4.29	38.1
Total	11.25	100.0
Moment of inertia		65.6
Section modulus, head		18.0
Section modulus, base		22.0
Ratio m.i. to area		5.83
Ratio s.m. head to area		1.60
Ratio height to base		1.20

Upper web and fillet.

Measurements showed that for the same conditions of loading, the maximum localized stresses in the upper web and fillets with the 115-lb. design are only 74 per cent as great as for the present 112-lb. RE rail. Considering the fatigue strength of the web steel as 60 000 p.s.i. in compression, a service loading condition which would produce a localized stress of this amount in the new section would produce a stress of 80 000 p.s.i. in the 112-lb. RE section. Since very few stresses of this magnitude were recorded in track with the 112-lb. section, it is believed that the new 115-lb. section offers adequate strengthening of the upper web and fillets.

Other modifications designed to reduce these localized stresses were considered, but none was thought as desirable as the revision recommended. An increase in the depth of the rail head, it was known, would lower the localized stresses, but would require more metal for equivalent results. At the same time, it was known that a decrease in width of the rail head might be expected to reduce the amount of eccentricity of loading. However, it was concluded that this would be undesirable because of the resulting increase in bearing pressure and internal shearing stresses produced by the wheel on a rail of such

design, and also because of the reduction in the lateral stiffness of the rail head, and the amount of metal available for side wear on curves.

A slight increase in radius of the lower web fillets is also incorporated in the 115-lb. section. In the tests, high stresses were found in the lower web fillets on curved track where the vertical loads were combined with high lateral loads. These fillet stresses and the longitudinal localized stresses in the rail base over tie plates with rolled-crown rail seats were high enough to cause serious concern.

Head contour.

The head contour of the new 115-section is a modification of that on the 112-lb. section, so that it simulates the normal outline of a rail that has become worn in service. The present 112-lb. contour is subject to heavy bearing pressure and initial flow at the gage corner until it becomes worn to fit the average wheel contour. It is expected that the new head contour will eliminate this initial flow and will delay the development of rail shelling and head checks to some extent. It may also be expected, it is pointed out, to produce more central loading on the rail head, thus reducing eccentricity of bearing and the resulting fillet and web localized stresses.

The lower corner of the rail head in the new 115-lb. design could be eliminated, as proposed by the Rail committee in one of its earlier reports, with a saving in weight of 1.3 lb. per yd. However, these corners were retained because of their advantages in the construction of frogs, switches, crossings, and insulated joints, and in increasing the lateral stiffness of the rail head.

The new 115-lb. rail section can be used only with joint bars of the headfree design. In the service tests and rolling-load tests of various designs of joint bars conducted for the Rail committee, the headfree joint bar gave as good results as the head-contact type of bar in terms of fatigue life, effectiveness of the joints, rate of wear, and amount of joint batter. The headfree design may have some advantage with respect to a lower rate of bolt tension loss and lower resistance to expansion movements of rail ends, but the principal advantage of the headfree design is that its use permits the desired thickening of the upper web and lengthening of the fillet radius.

The new design is based on the results of many service tests of joint bars. It has only a little less moment of inertia and section modulus than the present A. R. E. A. bar design for the 112-lb. rail, but is considerably lighter. It is believed that cracks which have sometimes developed in the tops of joint bars at mid-length are not due directly to sectional properties, because these cracks have also developed in the heaviest designs of joint bars.

In the recommended design of joint bar, the face-to-face distance has been held to a minimum to shorten the span of the bolts between the webs of the two bars of the joint. This will tend to increase the resistance of the bolts to bending and breakage when expansion forces bring the rail web to a solid bearing against the bolts. The recommended design of joint bar for the 115-lb. section will not fit the 112-lb. RE rail accurately, but might be used to join this rail to 115-lb. rail at the ends of relays, etc.

Fig. 2 shows the new rail section superseding the 131-lb. RE rail. This design weighs 132.1 lb. per yard, an increase of 1.3 lb., compared with the 131-lb. section. Substantially the same considerations apply to this revised design as to the 115-lb. section over the 112-lb. section, and the new section has the same over-all height and base width as the section it replaces, $7\,^1/_8$ in. and

6 in., respectively. With the wider head of the 131-lb. section, it was found possible in the revision to effect a considerable reduction in the maximum stress in the upper web and fillets by introducing compound fillet curves of longer radii and still accommodate head-contact joint bars as well as headfree bars.

Accordingly, new designs of both headfree and head-contact joint bars were developed and adopted for the new 132-lb. section. The head-contact bar may be used with either the new 132-lb. rail or with present 131-lb. rail, and may be used satisfactorily to connect these two rail sections at the end of rail relays, etc. The new headfree joint bar will not accurately fit 131-lb. rail.

Paralleling the development by the Engineering division research staff of the 115-lb. and 132-lb. sections, the Pennsylvania Railroad, having experienced a large number of web failures in 131-lb. RE rail, carried out an investigation of this section and other sections of similar and greater weight. This investigation involved laboratory tests on 14 rail sections, including sev-

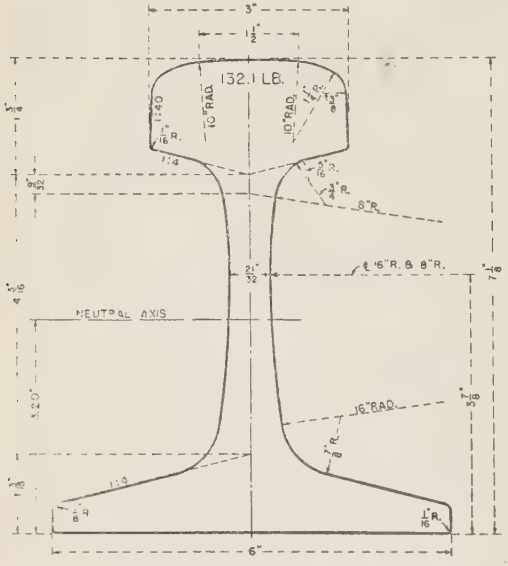
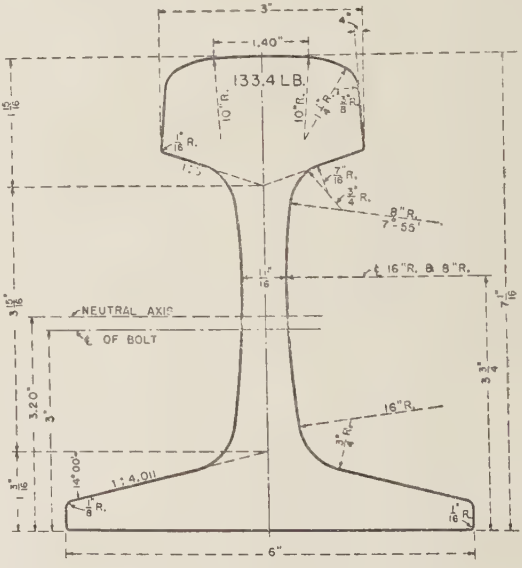


Fig. 2. — New 132-lb. RE rail section.

	Area Sq. In.	*Per cent.*
Head	4.42	34.1
Web	3.66	28.3
Base	4.87	37.6
Total	12.95	100.0
Moment of inertia		88.2
Section modulus, head		22.5
Section modulus, base		27.6
Ratio m.i. to area		6.81
Ratio s.m. head to area		1.74
Ratio height to base		1.??

Fig. 3. — New 133-lb. RE rail section.

	Area Sq. In.	*Per cent.*
Head	4.74	36.3
Web	3.47	26.5
Base	4.87	37.2
Total	13.08	100.0
Moment of inertia		86.0
Section modulus, head		22.0
Section modulus, base		27.0
Ratio m.i. to area		6.57
Ratio s.m. head to area		1.68
Ratio height to base		1.18



eral experimental sections. The primary development was the Pennsylvania's new 140-lb. PS section, which was designed for use in heavy-tonnage territory on divisions having a preponderance of heavy curvature.

Following the development of the 140-lb. section, the same principles of design were applied to develop a rail of approximately the same weight as the 131-lb. RE rail for use on divisions having less tonnage and curvature, but where tonnage and alinement are still such as to cause rapid head wear and where, due to the development of web failures, a rail of materially greater web strength than the 131-lb. section is desired. The result of this investigation was the 133-lb. rail section shown in Fig. 3, which has been adopted by the A. R. E. A.

The principal difference between the 133-lb. and the 132-lb. sections lies in the greater depth of head of the former. This was obtained at a slight sacrifice in moment of inertia (86 compared with 88 for the 132-lb. section) and of fishing height. The loss in fishing height was partly offset by adopting a head fishing angle of 1 in 3 (18 deg. 26 min.) like the 18-deg. angle of the old 130-lb. PS section. In overall dimensions, the new 133-lb. section has the same base width as the 131-lb. section, 6 in., but is $^{1}/_{16}$ in. lower, with an overall height of 7 $^{1}/_{16}$ in.

Lower web stresses.

Stresses in the upper part of the web of the 133-lb. rail were found to be materially lower, a condition which is due to the effect of the heavier head in spreading the load over a greater length of web. Both direct stress and bending stress in the web are thereby materially reduced.

A primary advantage of the 133-lb. rail for territory where head wear is a factor is the greater amount of metal in the head, permitting longer life in the first application and providing better rail for relaying after the first application. The thin head of the 131-lb. RE section has been one of its outstanding defects in curved track on heavy-traffic roads. Rail of this section removed from main-line tracks after 12 to 16 years of service has, in many instances, been found to be unfit for relaying in branch-line territory due to the thinness of the head. The 133-lb. section, with $^{3}/_{16}$-in. deeper head, is intended to remedy this defect.

Principles of web design similar to those used in the 132-lb. section were applied in the 133-lb. section, including a thickening of the upper portion of the web and the use of an increased fillet radius to reduce stress concentration. The web of the 133-lb. rail is slightly thicker at the minimum section and at the center line of bolt holes than the 132-lb. rail. The base of the 131-lb. rail and the lower web fillet radius are retained in the 133-lb. rail, no trouble having been experienced with these parts of the 131-lb. design.

The top contour of the head is practically the same as that of the 132-lb. section. A side inclination of 4 deg. is introduced in the rail head, giving a slightly narrower top surface of the head, and thus reducing the tendency to eccentric loading.

The greater top fishing angle is expected to reduce the tendency of the joint bars to « freeze », and this, combined with a lower bolt position, reduces the tendency of head-contact bars to « cock ».

While there was a preponderance of opinion in the Rail committee in favor of the 132-lb. section because of the advantage of the greater fishing height and the retention of the interchangeability with the present 131-lb. section, and also because the head section and range of web stresses in this section are believed to make it adequate for roads with moderate traffic, a considerable number of the members represent-

ing roads confronted with conditions of traffic and curvature that lead to rapid head wear expressed a preference for the 133-lb. section because of its greater head thickness and lower web stresses.

It was recognized that the roads favoring the 132-lb. section were generally those that had had little or no difficulty with the 131-lb. section, while those that had had difficulty with this section were generally favorable to the more pronounced changes of section provided in the 133-lb. rail.

A summary of the advantages of the new 133-lb. section, compared with the 131-lb. section, are as follows :

(1) Twenty-eight per cent lower stress in the top web fillet under eccentric vertical load.

(2) More metal in the head to withstand wear.

(3) Extended life of the rail in the worn condition.

(4) Greater top fishing angle (18 deg. 26 min., compared with 14 deg.), to reduce :

(a) tendency of the bars to cock;

(b) rate of take-up of the bars at the top;

(c) wedging action of the bars.

(5) A slightly narrower running surface, with a corresponding decrease in eccentricity of load.

The new designs of rails and joint bars were examined by the patent counsel of the Association of American Railroads and are said to be clear of infringement of existing patents. Furthermore, it is said that the A. A. R. will furnish patent counsel to handle the defense of any suit brought against a member road for the alleged infringement of any patent which has been issued, or any rail patent which may subsequently be issued, subject to the standing rule that the defendant member road is responsible for damages and profits in the event of unsuccessful litigation. It is considered that none of the designs of rail or joint bars adopted is patentable, it being claimed that prior art discloses the features of the new designs to be broadly old.

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Methods of improving strength, durability and wear resistance of concrete. (*)

(Railway Engineering and Maintenance, November, 1946.)

The railroads, public utilities and governmental agencies are now having to spend large sums of money to repair concrete masonry that was originally thought to be practically indestructible. One major railroad estimates that it has spent $ 3 000 000 during the past five years to repair or replace disintegrated concrete, and that an expenditure of an additional $ 1 000 000 will be required for similar work within the next five years. Another railroad, with less mileage, estimates that $ 200 000 will be required to be spent in the next five years. One railroad has already spent $ 300 000 to repair its concrete grade separation structures in one city alone. Several roads estimate they will have to spend around $ 100 000 a year on concrete repair work until such time as their necessary repairs catch up with disintegration.

The concrete enthusiast may think that all of the defective concrete referred to was placed before the water-cement ratio gained prominence. Such is not the case. One railroad reports that the present bid price for replacing defective concrete in 35 bridge structures, built between the years 1928 and 1930, is $ 100 000. The concrete for these structures was designed for 2 500 to 3 000-lb. concrete in accordance with the water-cement ratio theory in effect at that time, using well-graded aggregates and designed and placed under close supervision. Test cylinders showed strengths equal to or in excess of the designed strength. Abutments and walls were waterproofed on the back side and were backfilled with crushed stone drained by vertical and horizontal drains. The sad part of it is that no one has been able to determine the exact cause or causes of this desintegration.

Attention is called to the fact that several monumental concrete dams built within the last few years are already showing serious disintegration. The Parker dam, for example, was completed in 1938 by the U. S. Bureau of Reclamation at a cost of $ 6 000 000. Within 2 years' time it was found to be seriously disintegrated and experts do not yet agree as to the exact cause.

Most of the members of this Committee are construction men who have been in charge of placing concrete for a long time, and who have also had to remove or patch considerable concrete. None of us claim to be concrete experts. The average construction man has little, if any, time for research or investigation. You might say he is « on the firing line ». He takes the plans, specifications and materials furnished him and develops them into a finished product to the best of his ability and at the least possible cost. We are perturbed about the lack of durability of concrete, and we claim that we have a right to be perturbed when some of us see concrete we placed with pit-run, unwashed gravel, having say 60 percent sand and 40 percent pebbles mixed and placed by rule of thumb by unskilled men in un-

(*) *Report of Committee of the American Railway Bridge and Building Association, Annual Convention held at Chicago, on September 17-19, 1946.*

favorable locations, outlast concrete placed more recently under present-day rigid specifications.

Inherent weakness.

The inherent weakness of concrete as a building material, aside from the fact that one or more of the materials used in its manufacture may be defective, is that it involves innumerable opportunities for something to go wrong or for someone to do something wrong before it is actually mixed, poured, cured and ready for use. One mistake or omission may be all that is required to impair seriously the strength and durability of the finished product.

For instance, let us assume that a rush contract building job is under way. The specifications for the concrete are A-1; the cement and concrete materials delivered to the job are the best that could be desired; and we believe that everything is in readiness to pour a 100 percent perfect concrete floor. The concrete finishers then arrive on the scene and demand that the concrete be delivered with an excess of water, otherwise they will walk off the job. They expect to get the overtime pay while waiting for the concrete to dry out, or else.

Put yourself in the inspector's shoes and decide what kind of a floor that building owner is going to get. You say « that cannot happen here », but it has happened here. Until such time as the owner, who foots the bills for concrete maintenance work, and all of us who design and build concrete structures, wake up to the fact that durability of concrete is more important than the strength of concrete, the reputation of concrete as a durable building material will remain in danger.

As long as strength was considered the desirable feature to be obtained in concrete and we learned that the desired strength could be obtained by controlling the water-cement ratio, everything was rosy for the architect, the engineer, the cement manufacturer, the aggregate supplier and the contractor. We had something we could see and get our teeth into. We made 7-day and 28-day cylinders, crushed the cylinders, found that the correct strength was there, and everything was fine. We were all « authorities » on concrete. Now, 15 years later when this same concrete is showing serious disintegration and sizeable expenditures are required for repairs, the maintenance engineer finds these former « concrete experts » rather hazy in their recollections as to exactly how concrete of such inferior qualities was made.

Many disillusioned.

For several years many of us have been disillusioned with the water-cement ratio theory. We labored under the general opinion that too much water was the sole cause of all poor concrete. When inspecting any disintegrated structure built before this theory came into effect, we have taken one look at the structure and shook our heads knowingly with the remark, « too much water — it's a wonder it has stood up this long », and walked off. Now we may have to inspect a disintegrated structure on which we designed the mix ourselves in accordance with the water-cement ratio theory, using what we thought were A-1 aggregates, properly proportioned, and on which we know the test cylinders were satisfactory. This is an embarrassing moment, and probably the time when we must admit, at least to ourselves, that we are not experts on concrete.

Possibly the early users of steel had about the same trouble with that material that we are now having with concrete. Steel is now made under the direction of expert technicians, with close control from the raw material to

the finished product. The field and laboratory control of concrete should be under experienced men comparable with those of the steel industry. In addition to a « definite strength » concrete, we believe that specifications should call for a « definite life » concrete, say a 3 000-lb., 35-year life concrete, or whatever strength and life is desired, with the reasonable certainty that the cement and aggregates, if mixed, placed and cured properly under expert supervision, in accordance with the specifications, will give that strength and life. Every laboratory testing concrete materials should have specialized technicians who, after making the necessary tests on the cement and aggregate, and knowing the conditions under which the concrete is to be used, can estimate closely the life of the concrete to result from the materials tested. The one who furnishes the money for the construction is entitled to know what life concrete he is going to get. Perhaps 20-year concrete is all he wants. However, if he wants 50-year concrete, he should know that he is going to get it, and what it will cost.

Modern railroad bridge with concrete piers.

It is not uncommon practice to specify that the inspection of the concrete materials, as well as of the mixing and placing on the job, be taken care of by an approved laboratory at the expense of the contractor, and that the cost of this inspection be included in the contractor's bid price for the concrete. Under such a set-up, the laboratory is faced with the possibility that if it rejects any materials or workmanship, it stands the chance of not being employed on further work by the contractor. In some instances, when the railroad's field staff is inadequate, a railroad contractor will carry the concrete inspector on his own payroll. In such cases, those in responsible charge are evidently reluctant to forego all concrete inspection and, at the same time, are desirous of burying the cost of such inspection. In such cases, the owner still pays the full price, but stands a poor chance of obtaining good inspection.

Unless the concrete materials to be used have already proved their durability in actual use, or the railroad, or the owner, carries a competent staff of

concrete technicians to do the work, all concrete materials and mixing and placing should be in the hands of a competent laboratory, experienced in concrete work, and employed by and directly responsible to only the railroad or the owner. And here again, we say that the laboratory should be both competent and willing to deliver concrete of the life the railroad or the owner specifies. We believe that by now these laboratories are fully cognizant of the fact that the ills of concrete are many, but we insist that laboratory personnel, or, for that matter, any of us do not regard our responsibilities less seriously by reason of the fact that even poor concrete will last 15 or 20 years, when we will be on other work.

Much of the information contained in this report was obtained through a questionnaire sent to railroad men and representatives of other organizations, all of whom are well experienced in concrete manufacture. Replies were generous and the committee is appreciative of the assistance given.

This report covers only concrete that is exposed to weathering, freezing and thawing. Little will be said about strength, as we consider that the water-cement ratio theory and grading requirements that have been in effect for several years — with which you are all familiar — definitely control the strength of concrete. We are most concerned with durability, without which strength and wear resistance are unimportant. Many of us would gladly trade 1 000 pounds per square inch in our concrete strength for another 10 years of durability.

Many railroads have their own concrete specifications, and those who do not, use A. R. E. A., Portland Cement Association, or American Concrete Institute specifications, all of which are very good. One railroad prefers the National Crushed Stone Association's Bulletin No. 11 for proportioning. We will not discuss details of mixing, placing, etc., which are already covered in the specifications you use, and with which you are all familiar.

What should life be ?

In our questionnaire we asked, « In your opinion, what should be the life of a well-designed, well-placed and well-cured concrete, exposed continuously to weather in the northern part of the United States, using 5½ gal. of pure water per bag of cement, with a good grade of hard, crushed granite or trap rock for coarse aggregate and pure silica sand, with adequate fines, for fine aggregate, using Type-I Cement meeting present-day specifications? » Typical replies read, « No limit — better with age »; « 80 years upward »; « 60 years »; « 50 years or more »; « indefinite »; « a lifetime ».

To a question as to how one would alter or improve the above concrete to obtain longer life, the general opinion was that this concrete could be improved by being properly drained, and the exposed surfaces waterproofed against seepage water. This would give a concrete made from durable, inactive, non-laminated, non-absorbing aggregates, well drained and waterproofed against moisture. If the aggregates available to you in your territory approach the above in durability and non-absorption, and your workmanship is good, you are indeed fortunate, and you should have no serious trouble with your concrete.

To some, this might seem to be the answer to the complex question of how to obtain durable concrete. The quality of the aggregates used certainly do play an important part in obtaining sound concrete.

Comments on aggregates.

In preparing this report, it was interesting to note the comments relating to aggregates. One state department reported that it has used trap rock extensively and has had no serious trouble with concrete disintegration.

Another report on a 35-year pavement, without disintegration, in which quartzite was the coarse aggregate. Trap rock is not subject to laminations, is tough and non-absorbing. It has an absorption of 0.34 percent in 3 hours as against 1.19 percent to 1.62 percent for limestone, 1.17 percent for gravel, and 2.54 percent for slag. However, most of us believe that just as satisfactory concrete can be made from other aggregates if the proper precautions are taken to obtain sound materials. This is fortunate, as we are, of course, obliged to use the highest quality of materials that are economically available, the quality to be judged by close observation and tests of the component parts, as well as the finished product.

Laboratory tests.

Accelerated laboratory tests of concrete and concrete materials that will duplicate actual field conditions, have not yet been developed. When we consider that one of the main constituents of cement starts to hydrate immediately and completes hydration in about 28 days, while another equally important one does not start hydration for several days and continues hydration as long as water is present, we have some idea of the difficulties of laboratory tests duplicating field conditions. In the case of the Parker dam, it was found that at the time the outer shell was shrinking with progressive drying, the interior concrete, where the residual mixing water was still available, was swelling.

Cement.

When the ingredients of portland cement are burned at a high temperature and then cooled, they combine and form tricalcium silicate, dicalcium silicate, tricalcium aluminate and tetra-calcium alumine ferrite, with small amounts of calcium sulfate, magnesium oxide and alkalies. The combining of these compounds is largely affected by the time and temperature of burning and the rate of cooling.

In the mixing of cement and aggregates to make concrete, the hydration of tricalcium silicate starts immediately, is about complete in 28 days, and is responsible for early strength, accompanied by considerable heat. The dicalcium silicate does not start to hydrate until several days after mixing and continues hydration indefinitely in the presence of water. Tricalcium aluminate is responsible for early strength, generates high heat, is responsible for excess expansion, is most affected by aggressive water, and is responsible for several of the undesirable qualities of cement.

We know that cements are not alike, although they meet a certain definite specification. To the construction man, the standard A. S. T. M. specification for chemical requirements for Type-I cement, which is the type most universally used, is conspicuous by its failure to place any limit on but 4 of a possible 11 limitations. To this man, it would seem that almost anyone could make Type-I cement, although plant chemists assure us that such is not the case. Be it as it may, it seems to us that the chemical requirements for Type-I cement should be more comprehensive, as Type I is the cement most universally used.

A. S. T. M. Type-II cement is more closely controlled than Type I. It is lower in tricalcium aluminate, which results in reduced heat, with less volume change and greater resistance to alkali water. This type cement is used extensively on Bureau of Reclamation work in place of Type I, and we believe it deserves your consideration for future work, particularly for massive sections, where considerable heat will be generated.

Type-III high-early-strength cement is used on emergency work where early high strength must be obtained. Its high content of tricalcium aluminate, required for early strength, is not conducive to durability.

Type-IV low-heat-cement and Type-V

sulphate-resisting cements are special cements to meet special field conditions, as indicated by their designated names.

Keep cement to minimum.

The cement content of concrete should be kept to a practical minimum. It is the most unstable of the concrete materials. It generates heat with accompanying contraction and expansion, changes in volume with moisture, and is subject to action by active water. Also, if the cement contains excessive free lime or alkali, any cement over and above the minimum required means that the resulting concrete will contain more of these undesirable substances. Surely there is no good reason for an excess of cement, although this is one of the most common abuses of the material. We frequently use a little more cement than we think is actually required, just to play safe.

Starting about 1940, a lot has been said about the disintegrating reaction between cements high in alkali and certain aggregate in the Northwest. The excess alkali in cement is considered as a rover that has not become fixed by being incorporated in the cement, and reacts destructively with some type aggregates. The finer the cement, the easier the alkali is released. Opaline silica is the one constituent of aggregates which, practically all agree, reacts unfavorably with high-alkali cement. A well illustrated article relative to this and other types of disintegration is to be found in Public Roads, Volume 24, No. 4 of April, May and June, as reported by F. H. Jackson, principal engineer of tests, Public Roads Administration. This disintegration, prevalent in the Northwest and West, appears more serious and pronounced than in the central states, where we believe our worst trouble comes from freezing and thawing. However, if there is any doubt as to the cause of your trouble with concrete, we recommend that you limit the alkali content of your cement, at least until such time as your aggregates are definitely pronounced non-reactive, as only 2 percent of reactive aggregates is enough to cause trouble.

Aggregates.

Unsound, improperly-graded and segregated aggregates, just about top the list as the cause of poor concrete. Unless your fine and coarse aggregates have already proved their durability in actual construction, they should be thoroughly investigated by sodium or magnesium sulphate soundness tests, or freezing and thawing tests, or both. Even if they have already proved their durability, there may be some doubt as to their reliability when used with present-day cement. Considerable importance is now being given to freezing and thawing tests on concrete test beams to determine their loss in flexural strength after several cycles of freezing and thawing, as flexural strength is more sensitive to freezing and thawing than compressive strength.

Trap rock and granite head the list as preferred coarse aggregates. However, sound, well-graded gravel, dolomite or limestone, and blast furnace slag, are considered satisfactory if they meet present-day specifications. Low absorption and high specific gravity are indications of sound aggregates.

Chert, shale and unsound particles are the worst offenders in gravel. Chert has all the appearances of a sound stone and, for that reason, is particularly treacherous. Some cherts are satisfactory for use, and we doubt if unsound chert can be distinguished from sound chert, except in the laboratory. Chert with a specific gravity below 2.35 is considered as definitely unsound. Shale should be kept to a minimum, as it disintegrates from weathering.

Dolomite is considered as tougher and harder than low-magnesium limestone. Both of these stones, when freshly quarried and exposed to the air, are subject to deterioration. Railroads are

careful to select stones that are not subject to laminations, as some poor concrete is directly traceable to this defect. Most railroads prefer that crushed stone be washed. Excess dust on the stone is an indication that the stone is too soft. Sandstones are frequently friable or excessively porous because of imperfect cementation of the grains. Blast furnace slag is used extensively by highway departments, particularly in pavement work. It is more resistant to sulfate action than some stone. However, some railroads consider it too porous and subject to pop-outs.

Sand.

In selecting sand, care should be taken to see that the grains are solid particles. Grains that are formed by the cementing together of many smaller particles tend to disintegrate.

Sand should be washed. The closer sand is to pure silica, the better. Sands high in silica, felspar and calcium carbonate will absorb very little moisture. Care should be taken to see that 12 to 30 percent by weight will pass the No. 50 sieve and 3 to 10 percent the No. 100. As most sands, when washed, do not contain this high a percentage of fines, it is often necessary to add additional fine sand. Sand manufactured from stone is not considered satisfactory. Natural sand taken from a pit where the gravel contains excess chert, or other deleterious substances, should be very carefully investigated. Only enough sand should be used to give a workable mix. Any sand over the required amount automatically adds more water to the mix, which is undesirable.

It is desirable that laboratory tests be made of all cements and aggregates available to your railroad, and that this information be readily available in order that the most suitable materials may be selected for any particular job without undue delay. You will not go wrong in specifying that aggregates meet A.R.E.A. or local state highway department specifications.

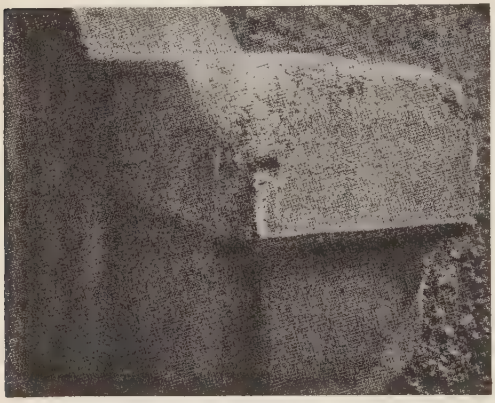
Curing.

In curing is where most of us fail miserably in our efforts to obtain good concrete. When we consider that one of the main constituents of cement does not even start hydration for several days after pouring, and then only in the presence of water, and that from 50 to 75 percent of the effectiveness of the cement is lost if curing is stopped too soon, we can better understand why curing is necessary. Inadequate curing may affect only the outer shell of concrete, as farther inside the mass the retained water may be sufficient for curing. However, this internal concrete robs moisture from the outer shell, and if the outer shell does not have sufficient water, it will shrink while the inner concrete is expanding, causing the outer shell to check and crack seriously, and thus reduce the life of the concrete. Concrete expands and contracts with wetting and drying. The old method of applying curing water with a hose, then permitting the sun to dry out the concrete before applying water again, contracts and expands the green concrete until this outer shell, one might say, is « all worn out » before it is even ready to use. Both the amount of moisture for curing and the temperature of the concrete should remain as constant as possible.

Excess water is necessary for cement hydration. Theoretically, the curing should continue for several months. As this is impractical, it should be continued for not less than 7 days and, if possible, 14 days.

Curing compounds are now on the market and, in some instances, as when concreting close to electrical work, are absolutely necessary. However, we are of the opinion that there is no substitute for excess water, which must be present in order for the cement to hydrate.

The freezing and thawing of concrete while in a saturated or near saturated condition is another predominant cause of disintegration. To resist this, the concrete should be dense, with the coarse aggregate having a co-efficient of expansion as close as possible to that of the cement mortar, and non-absorbing



An example of disintegration at the end of a concrete wing wall.

in character, and using as low a water-cement ratio as possible to obtain a workable mix. In addition, the surface water must be kept out. If it cannot be kept out, it must be drained away quickly.

All horizontal exposed surfaces should be pitched to drain the surface. In addition, the top surfaces of bridge seats, wing wall, retaining walls, etc., should be thoroughly waterproofed to keep water from soaking in.

The backs of all walls must be drained and waterproofed. The form for the back of abutments and walls can be moved back two or three feet and left in place, the space between it and the masonry being filled with coarse crushed stone, inside which a complete horizontal and vertical drainage system is built. The prime coat of waterproofing should penetrate the pores of the concrete to be effective. Hot tar and asphalt, or tar and asphalt emulsions with suitable primers, are effective waterproofings for the back of walls. A prime coat of hot 50 percent turpentine and 50 percent raw linseed oil, with a second coat of hot, raw linseed oil, is effective for top surfaces, over which a good oil base concrete paint may be applied, if required.

Air entraining.

It is thought that the use of air-entraining concrete may prove to be a greater asset to concrete durability than the development of the water-cement ratio theory. A. S. T. M. specifications are in force covering the use of both vinsol resin and Darex as air-entraining agents. Other air-entraining and dispersing agents are in use and are proving satisfactory. However, as yet, no authoritative specifications covering them are available, which limits their use.

Air-entraining cement may be purchased, or the agent may be added at the mixer. At the present time, it is recommended that it be added at the mixer.

Although air-entraining is still somewhat experimental, insofar as its use in structures is concerned, we think you should give it a trial in your structures. It will decrease somewhat the strength of rich mixes, but will increase the strength of lean mixes. Bond strength will be somewhat reduced. The water and sand content of the concrete, however, can be reduced, and workability and segregation of aggregates will be much improved, and bleeding reduced.

General.

Following are some of the things the various railroads are now doing to improve their concrete, listed approximately in the order of their importance :

(1) Better selection and grading of aggregates.

(2) More care to prevent segregation.

(3) More attention to water-cement ratio and better water control.

(4) More careful curing.

(5) Better and more careful supervision.

(6) Specify compactness. Slump held as low as possible.

(7) Watch fine aggregate to get 10 to 30 percent passing No. 50 sieve and 2 to 10 percent passing No. 100 sieve, with fineness modulus of 2.40 to 2.80.

(8) Use only weight proportioning.

(9) Waterproof and drain backs of all abutments and walls, and waterproof top surfaces of all piers, abutments and walls.

(10) Indicate all pours and joints on the plans.

(11) All pours in one operation.

(12) Remove and waste top of pour after concrete has been in place long enough for the fines and laitance to come to the top.

(13) Better attention to details.

Much poor concrete is at construction joints. Joints should be detailed to keep water entirely out of and away from these joints. Concrete is often dumped into the form and worked toward the joint. Due to segregation and bleeding, an excess of water thus collects at the ends, resulting in concrete having less weather resistance at these points. Actually, the concrete should be kept slightly higher at the ends of the sections than at the middle.

On thin sections, leave an open joint. Tongue and groove joints in thin sections are not desirable. An effective water stop, caulking, or waterproofing applied over a joint at the back of a wall, is considered more effective than a lead or copper waterstop inserted in the wall. All vertical joints should be caulked or waterproofed across the top to keep moisture from getting into the joint from above. In any case, keep the water out or get it away fast. It is saturated concrete that disintegrates with freezing and thawing. Everything possible should be done to keep water out.

Placing.

Vibrated concrete, when properly controlled, is superior to hand placed concrete. Vibration permits the use of stiffer mixes, which have less water and less tendency to segregate. It results in less honeycombing and fewer porous spots. If the mix is kept sufficiently stiff, the danger of over-vibrating is slight. The danger comes from vibrating too wet a mix, in which case serious segregation will occur.

Concrete should be placed in the forms as near as possible to its final position. Shoving it toward the ends of the form should not be permitted. Most of our poor concrete is at the ends of wings and at construction joints, where the concrete has been shoved some distance, causing segregation and water gain. Chuting into place is conducive to segregation and should not be permitted.

Aggregates should be proportioned by weight. It is hoped that automatic recording instruments will soon be available for both small and large jobs, so the man in the field can see at a glance the different weights of all materials that have entered every batch. A method of instantly obtaining the moisture content of sand would be a godsend to the concrete inspector, and would insure a more uniform and economical mix.

Concrete to resist sea water or alkali must be dense and impermeable, preferably employing sulfate-resisting cement. The reinforcement should have at least 2½ in. coverage, and the surfaces of the concrete should be waterproofed with acid-resisting waterproofing.

Mixing water should be clear, fresh (not salt) and free of organic matter, acids, alkalis or other deleterious substances. In general, water fit for drinking purposes will be satisfactory

for mixing, except in alkaliwater districts, where all water should be tested.

Poor concrete is more liable to be at the top of pours, where the water and laitance collects. Concrete can be brought to the top of the form and allowed to set a short time, after which the top few inches can be removed and wasted, being replaced with fresh concrete. Or the concrete can be brought to within 12 to 18 in. of the top, then allowed to set a short time, after which the form should be filled with a drier mix.

Other considerations

Concrete will settle away from structural steel members or reinforcing steel anchored near the top of high pours, causing voids which will later collect damaging water. The only suggested remedy is to pour to the underside of the steel and allow the concrete to set enough to eliminate at least some of the settlement. For this reason, round horizontal reinforcing is preferable to square bars.

Expansion joints in retaining walls should be spaced 20 to 30 ft. apart, preferably constructed so each section stands alone. Reinforcing steel across a construction joint is not desirable, and a vertical keyway tends to collect water which may develop a head, in addition to reducing the concrete section at that point. It would seem good practice to drain the bottoms of construction joints.

Expansion joints in pavements at 100-ft. centers, with dummy joints $1\frac{3}{4}$ in. deep on 20-ft. centers, is good construction.

One railroad obtains good wearing floors and pavements by using trap rock or other tough stone for a topping. The concrete is mixed with not more than $3\frac{1}{2}$ gal. of water per bag, which requires the use of a mechanical float. The surface is then troweled and later roughened with fine bristle brushes. If exposed to the weather, air-entrained cement is used. Adequate water curing is insisted upon. Heavy-duty floors can be constructed in two courses, with a top finish $\frac{3}{4}$ in. to 1 in. thick, containing tough pea gravel or other small size durable aggregate graded from $\frac{1}{8}$ in. to $\frac{3}{8}$ in., applied to the base slab before it has taken its initial set. This should be placed as stiff as possible, with a 1:1:$1\frac{1}{2}$ or 2 mix, using a power float. A mortar topping should not be used for heavy-duty floors or bearings under heavy load. Several railroads use iron troweled into the finish coat for inside floors, with favorable results, excepts for some discoloration.

We are well aware that this report omits entirely many important questions concerning concrete and barely mentions some in which you are intensely interested. The subject is much too broad to cover in one report. The best we can expect is that this will serve as a stepping stone to further work on this subject.

Conclusion.

To improve the strength, durability and wear resistance of concrete exposed to the elements, design for strength in accordance with the water-cement ratio and use as small an amount of sand and cement as possible to obtain the desired workability. Use well-graded, durable, non-absorbing, non-laminated coarse aggregate, with durable sand having sufficient fines. Use low-alkali cement unless positive your aggregates are non-reactive with alkali. Provide adequate drainage. Waterproof the back sides of all walls in contact with earth, and waterproof all exposed flat surfaces. Prevent all trapping of water. Weigh the aggregates. Provide adequate curing. Use air-entrainment if subject to freezing and thawing and, above all, provide adequate skilled supervision.

[385. (06. 111]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

Final summaries adopted at the fourteenth Session (Lucerne, June 1947).

SECTION I. — Way and Works.

QUESTION I.

Sleepers :

a) different types;
b) maintenance methods;
c) financial comparison.

Summary.

« 1. Of the various types of sleepers, « the wood sleeper is still far and away « the most widely used. Soft and resin- « ous woods are used as well as hard- « woods; the railway's choice of timber « varies according to the resources of « the country and economic circumstan- « ces.

« Each system has adopted dimensions « and conditions of supply to meet its « requirements; such dimensions and « specifications do not differ very much « as a general rule.

« 2. After natural or artificial season- « ing, it is desirable to impregnate wood « sleepers by means of some antiseptic « product, which prevents rot and ap- « preciably lengthens their life. The « most widely used and most effective « product is tar oil or creosote. It « would be interesting to study more « deeply substitute products for creosote. « Impregnation should preferably take « place in the railway shops at the same « time as the sleepers are adzed and bor- « ed, as then the work is more likely to « be properly done.

« 3. The method used to fasten the rail « to wood sleepers plays an important « part in the conservation of the latter; « mechanical wear of the sleeper, to- « gether with rot, is in fact the main « cause of deterioration. On many Rail- « ways flat bottomed rails are laid directly « on the sleepers and secured by means « of spikes or coachscrews with good « results; for lines with heavy traffic, or « where there are small radius curves, « the use of sole plates with direct fast- « enings, or better still indirect fasten- « ings, is likely to prolong the life of the « sleepers appreciably. Chairs have to « be used with bullheaded rails. The « placing of pads made of special wood « or preferably of rubber has produced « interesting results on some systems.

« 4. From the point of view of « strength and life, metal sleepers can « replace wooden sleepers except, of « course, where track circuiting is in-

« volved. They are preferable in tro-
« pical countries where wood perishes
« very quickly.

« It would seem preferable to fasten
« the rails by means of sole plates or
« chairs welded to the sleepers rather
« than make use of direct fastenings with
« clips or spikes and bolts.

« 5. Concrete sleepers are not yet
« widely used, though certain types made
« of ordinary reinforced concrete have
« given quite good results; present re-
« search would seem to be concentrating
« on prestressed concrete. The fasten-
« ing of the rail to concrete sleepers is
« still a difficult problem.

« 6. The conservation of the sleepers
« depends to a large extent on the main-
« tenance of the correct level of the track.
« This maintenance can be carried out
« either by tamping, by hand or mechan-
« ically, or by measured shovel packing.
« The latter gives excellent results, and
« is being more and more used.

« The repair of defective fastenings by
« the appropriate means is another es-
« sential factor for prolonging the life of
« sleepers; such repairs usually are made
« in conjunction with re-adzing, re-cut-
« ting the shoulders, and repairing any
« splits.

« Owing to the present shortage of la-
« bour, the use of mechanical methods
« for all maintenance work is to be
« greatly recommended.

« 7. Maintenance of metal sleepers in
« the track is limited to tightening up
« the fastenings. Repairs to cracks by
« welding and the replacement of the
« sole plates can only be done when the
« sleepers are taken up.

« The only maintenance operation pos-
« sible with concrete sleepers is the re-
« placement of the fastenings.

« 8. When its appreciably shorter life
« is taken into account, the softwood
« sleeper, in spite of its lower first cost,
« costs more per year of service than a
« hardwood sleeper.

« Although the information supplied
« by the different Railways does not
« make it possible to say so definitely, it
« would appear that, leaving aside those
« countries rich in timber, the cost of
« impregnating sleepers is made good by
« their longer life.

« The use of metal sole plates, espe-
« cially with indirect fastenings, pro-
« longs the life of wood sleepers, but the
« figures supplied do not make it pos-
« sible to conclude that there is a defi-
« nite economic advantage to be obtained
« thereby. The same applies to every
« device capable of reducing the hammer-
« ing of the rail on the sleeper.

« In steel producing countries, the me-
« tal sleeper may compete with the wood
« sleeper from the point of view of an-
« nual cost.

« It is not yet possible to give any
« definite opinion from a financial point
« of view concerning concrete sleepers,
« the price of manufacture of which is
« high. If they can be given a suffi-
« ciently long life by careful manufac-
« ture and a suitable method of fasten-
« ing, their annual cost may become
« lower than that of wood or metal
« sleepers. »

2nd and 5th Sections together :

2nd SECTION. — Locomotives and rolling stock.

5th SECTION. — Light railways and colonial railways.

QUESTION II.

Lightening the rolling stock.

Reduction in the weight of rolling stock (passenger and goods) by :

a) choice of the method of construction;

b) use of special steels;

c) use of alloys.

Summary.

A. Conclusions relative to passenger rolling stock.

« 1. There is a general tendency towards reducing the weight of all steel passenger stock without adversely affecting strength or comfort.

« 2. Whatever the quality of the steel used it has been possible to reduce, by a large proportion, the weight of passenger stock by careful design of all parts and by the use of sections made of thin sheets welded together.

« Usually the underframe-body structure is of the tubular girder type which has a high moment of inertia and the ends of which are specially braced and reinforced to resist shock.

« Static and dynamic tests of the underframe-body structure are considered desirable. The use of strain gauges for such tests is most suitable.

« 3. Ordinary carbon steel is still most generally used for building passenger stock. However, the use for that purpose of weldable low alloy steel with a high elastic limit, as well as the use of rustless steel, is becoming more common.

« 4. Light alloys can be widely used for many detail sections and for interior fittings.

« They are also used in the building of structure assemblies on passenger stock of some light railways, but on main line railways their use for that purpose does not seem likely to be developed.

« 5. The lightening of bogies can be obtained to some extent by using welded or rivetted thin plates for underframe construction and by replacing laminated springs by helical springs or the use of torsion bars controlled by shock absorbers.

« It is also interesting to mention the combined use of rubber and steel for main suspensions and the use of rubber suspended wheels.

« Designs at present in use allow for increase in comfort and it would be possible to further reduce the weight of the vehicle by replacing the heavy bogies in present day use.

« 6. Lightweight rolling stock has been in service too short a time and in too small numbers to give any definite results as to its advantages both from the point of view of economy and savings in wear on the permanent way but certain advantages do appear to be apparent. »

B. Conclusions relative to goods wagons.

« 1. Railway Administrations are endeavouring to reduce the weight of their goods wagons as much as possible.

« 2. The lightening is achieved in general by the use of welded construction of the underframe members and bodies and also by the partial use of pressings which permits of reduction in thickness whilst maintaining sufficient rigidity.

« 3. Ordinary steels are normally employed for goods wagons.

« Light alloys are sometimes used for certain details. Experiments are being carried out with light alloys for the principal framing.

« 4. The possible saving in weight for goods wagons is low in comparison with that for passenger stock.

« The reduction in weight should not be developed beyond a point where it is not a *commercial proposition.* »

3rd SECTION. — Working.

QUESTION III.

As regards passenger traffic, to report on the best policy for the organisation of the train services from the points of view of frequency and composition of trains, to ensure successful transport at the lowest possible cost, whilst giving passengers reasonable facilities.

To consider in turn the cases of steam and electric lines, showing the extent of using steam trains and railcars for the former, and electric motor coaches and electrically driven trains for the latter, on lines with heavy, average, and light traffic, during and outside rush hours of the day.

Summary.

« 1. The passenger fares should be readjusted in order to approach, as near as is judged possible, a level which would enable an equilibrium of passenger traffic expenditure.

« If passenger fares were too low, the Railway Administrations having the balancing of their budget in mind, would be forced either to deprive their clientele of indispensable facilities or to increase the goods rates which would render them particularly vulnerable to road competition.

« 2. In order to avoid the inflation of train mileages, the latter should be fixed at a level exactly adapted to the necessities of a rational service giving satisfaction to the clientele.

« *On main lines.* In principle, « speed at all cost » should be given up, sufficient day and night services being maintained between large centres.

« However, on lines where a potential development of traffic exists, a few high speed trains offering great comfort will be operated in order to facilitate and encourage travel.

« Electrification of these routes appears interesting, electric traction being a means of obtaining economically a frequent and speedy service likely to promote an increase of traffic.

« Long distance slow trains are costly on account of their poor utilisation on

« the greater part of the route. They « can be replaced by short distance « trains whose composition can be more « justly appropriated to potential traffic, « timings better adapted to the needs of « the clientele and whose higher com- « mercial speed will enable an easy oper- « ation of the lines with fast and fre- « quent services. The fast and slow « trains will be usefully replaced on the « main lines by powerful rail cars.

« In order to meet the fluctuations of « the traffic, these rail cars should be « able to be coupled and have a reserve « of power sufficient to take an extra « vehicle without an excessive repercus- « sion on the time-table.

« *The service on secondary lines* will « be covered by a shuttle service of rail « cars which can be coupled and have « sufficient power to haul one or two « trailers.

« A steam train shuttle service could « eventually be provided for fast trans- « port which could not be dealt with by « the rail cars.

« *The service on suburban lines* would « be covered by sets of trains of regular « frequency, each train of the set being « affected to the service of determined « stations or of a determined zone.

« These lines would be electrified in « order to develop and speed up the serv- « ice with a view to increasing the clien- « tele.

« There is a great interest in running « through coaches, specially for night « travel, on the more frequented lines, in « order to avoid detraining of passengers « at inconvenient hours.

« It is also necessary to develop sleep- « ing berths of all kinds in order to « combat the competition of other means « of transport.

« 3. The weight of the rolling stock « should be lighter in order to reduce « traction and maintenance costs, and to « render possible an increase either of « the speed, or of the capacity of pas- « senger trains.

« Whereas before 1940 the average « weight of metal vehicles on European « main lines increased to over 40-tons, « the building should be undertaken of « passenger vehicles lightened to a maxi- « mum compatible with safety and com- « fort at least equal to those existing at « present.

« 4. The traffic peaks which occur at « certain periods bear heavily on the « running costs of the passenger traffic, « as the rolling stock required to cope « with additional services remains un- « employed during the great part of the « year. It is desirable to reduce them, « for example by the following means :

« a) the reduction or cancellation at « holiday times of the tariff concessions « granted to certain categories of pas- « sengers;

« b) eventually, the bringing into « force of positive tariff measures induc- « ing passengers to arrange their jour- « neys outside holiday periods ;

« c) the limitation of the number of « seats offered by rendering compulsory « the advance booking in certain trains;

« d) by a more intensive utilisation of « the rolling stock required in normal « traffic;

« e) by organising the maintenance « and repairs in order to reduce to a « minimum at critical times the immo- « bilisation of coaches in repair and « maintenance shops;

» f) by taking steps with the compe- « tent authorities to obtain a better

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GUILLET (L.). — Influence de la structure et de la composition des **alliages métalliques** sur leurs propriétés élastiques. (6 000 mots & fig.)

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1946 **385 .113 (.71)**

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Les deux **grands réseaux du Canada en 1945.** (1 600 mots & tableaux.)

1947 **385. (09**

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1947 **385 .113**

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PARMELEE (J. H.). — Evolution des **chemins aux Etats-Unis** en 1946. (2 500 mots.)

1947 **656 .231 (.**

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TÖRNQVIST (L.). — **Refonte des tarifs** des ch de fer de l'Etat de Finlande. (2 000 mots & tabl

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1947 **38**

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LE BESNERAIS (R.). — **Les grands organismes viaires internationaux.** (5 000 mots.)

1947 **621 .33**

Bull. de l'Union intern. des ch. de fer, janvier-f
p. 29.

L'**électrification** des chemins de fer français. mots.)

1947 **621 .33**

Bull. de l'Union intern. des ch. de fer, janvier-f
p. 31.

CIRILLO. — L'**électrification** des chemins de f liens de l'Etat (1 500 mots & fig.)

1947 **621 .33 (.42) & 621 .431 .72**

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1947 **313 .385**

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47 **656 .24**

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ité et du cas de dol ou de faute lourde du chemin
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47 **385 .113 (.489)**

des transp. intern. par ch. de fer, mars, p. 134.
Chemins de fer de l'Etat danois en 1945/46. (600
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47 **385 .113 (.485)**

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(1 000 mots.)

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47 **385. (09 (.47)**

des transp. intern. par ch. de fer, mars, p. 139.
xtension du réseau des Chemins de fer de l'U.R.S.S.
) mots.)

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47 **385. (09 (.73)**

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47 **624 .63 (.61)**

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ESSINGER (F.). — Le **pont** sur la Medjerdah à
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éton précontraint. (6 000 mots & fig.)

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47 **621 .134 .4**

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UMGARTNER (J.-P.). — La **locomotive à vapeur**
ound à trois cylindres. (1 700 mots.)

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7 **625 .142 .2 & 694**

Civil, n 3200, 1er mars, p. 89.
ZOUS (P.). — Le Congrès International pour l'**ex-**
tion et l'utilisation rationnelle du bois (Paris,
septembre 1946.) (4 500 mots.)

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47 **621 .132 .3 (.42) & 621 .132 .4 (.42)**

Civil, nº 3201, 15 mars, p. 117.
locomotive mixte à voyageurs ou à marchandises
chant Navy » du Southern Railway (Angleterre).
) mots & fig.)

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47 **623 (.44) & 624 .63 (.44)**

Civil, nº 3203, 15 avril, p. 145; nº 3204, 1er mai,
. 168.
ANSIGAUD (A.) & MARTIN (M.). — La **recon-**
ion du viaduc de Nogent-sur-Marne sur la ligne de
n de fer de Paris à Bâle. (5 000 mots & fig.)

1947 **62. (01**

Génie Civil, nº 3203, 15 avril, p. 149.
BASTIEN (P.). — Les applications industrielles des **rayons X.** (2 000 mots & fig.)

1947 **621 .132 .8 & 621 .438**

Génie Civil, nº 3203, 15 avril, p. 151.
L'avenir des **locomotives à turbines à gaz.** (1 600 mots, 1 tableau & fig.)

1947 **621 .132 .3 (.44)**

Génie Civil, nº 3204, 1er mai, p. 165.
MARTIN (H.). — La **nouvelle locomotive compound à 3 cylindres 242-A-1** de la Société Nationale des Chemins de fer français. (2 800 mots, tableau & fig.)

1947 **621 .431 .72 (.44)**

Génie Civil, nº 3204, 1er mai, p. 179.
L'**autorail** léger F. N. C. (800 mots & fig.)

L'Ossature métallique. (Bruxelles.)

1947 **624 .32 (.944)**

L'Ossature métallique, nº 2, février, p. 63.
Nouveau **pont** sur le Hawkesbury River (Australie). (1 300 mots & fig.)

1947 **624 .32 (.493)**

L'Ossature métallique, nº 2, février, p. 67.
HORMIDAS (A.). — Construction d'un **pont provisoire sur la Meuse** à Liége. (2 800 mots et fig.)

1947 **624 .4 (.44)**

L'Ossature métallique, nº 2, février, p. 81.
Reconstruction du pont-route de la Mulatière à Lyon (France). (1 000 mots & fig.)

1947 **624 .63**

L'Ossature métallique, nº 3, mars, p. 105.
LEMAIRE (C. F. B.) . — L'emploi de cintres métalliques dans l'établissement de grandes **voûtes en béton.** (5 000 mots & fig.)

1947 **624**

L'Ossature métallique, nº 3, mars, p. 129.
DAVIES (D. J.). — Développements récents dans **l'entretien des ponts métalliques de portée moyenne.** (4 000 mots & fig.)

1947 **62. (01 & 621 .392**

L'Ossature métallique, nº 3, mars, p. 138.
JOUKOFF (A. S.). — Bases du calcul des **assemblages par points soudés.** (8 000 mots & fig.)

1947 **624 .92**

L'Ossature métallique, nº 4, avril, p. 155.
INDACO (F.). — Le **tube d'acier** dans la construction des charpentes. (1 500 mots & fig.)

1947 **669 .1 & 691**

L'Ossature métallique, n° 4, avril, p. 167.

Essais de corrosion naturelle de longue durée sur divers aciers de construction dans l'air atmosphérique et dans différentes eaux de mer et de rivières. (10 000 mots, tableaux & fig.)

Revue de l'Aluminium (Paris).

1946 **669**

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PETREQUIN (P.). — **Tubes et profilés à section variable.** (3 000 mots & fig.)

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1946 **385. (09 (.494)**

Revue de l'Assoc. franç. des Amis des Chem. de fer, septembre-octobre, p. 75.

GACHE (A.). — Les **Chemins de fer suisses.** (20 000 mots, tableaux & fig.)

1946 **385. (09 .3 (.44)**

Revue de l'Assoc. franç. des Amis des Chem. de fer, novembre-décembre, p. 105.

VAUQUESAL-PAPIN. — Le **Centenaire de l'inauguration du Chemin de fer du Nord.** (30 000 mots, tableaux & fig.)

1947 **625 .258**

Revue de l'Assoc. franç. des Amis des Chem. de fer, janvier-février, p. 7.

ZOUKERMANN (A.). — Les récents progrès du **frein électro-magnétique sur rail.** (5 000 mots & fig.)

1947 **625 .2 : 625 .62 (.45)**

Revue de l'Assoc. franç. des Amis des Chem. de fer, janvier-février, p. 14.

CAIRE (D.). — La **voiture de tramway à grande capacité** de Gênes. (1 200 mots & fig.)

1947 **623 (.44) & 624 (.44)**

Revue de l'Assoc. franç. des Amis des Chem. de fer, mars-avril, p. 25.

CARPENTIER (L.). — **La reconstruction des ouvrages d'art** de la S. N. C. F. (10 000 mots & fig.)

Revue générale des chemins de fer. (Paris.)

1946 **621 .133 .3**

Revue générale des chemins de fer, novembre, p. 195.

JOUMAT (P.). — Les **zones marginales des tôles** pour chaudières de locomotives. (1 500 mots & fig.)

1946 **625 .233**

Revue générale des chemins de fer, novembre, p.

CAILLET. — L'**éclairage des voitures** de chemi fer par la lumière fluorescente. (1 000 mots, table fig.)

1946 **385 .51**

Revue générale des chemins de fer, novembre, p.

Les « **Comités mixtes d'entreprise** » à la S. N. (1 500 mots & fig.)

1946 **385. (09**

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Organisation et développement des **transports par mins de fer** en U. R. S. S. (3 500 mots & tableaux

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1946 **621 .**

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ROY (M.). — La **locomotive à cylindres a-t-elle** (2 500 mots, tableaux & fig.)

1946 **625**

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PEDELUCQ. — Le **freinage** des véhicules de ch de fer. (7 000 mots.)

1946 **623 (.44) & 656 .213**

Revue générale des chemins de fer, décembre, p.

GONON & DOUDRICH. — Destructions et r structions sur les Chemins de fer français (Suite) **ports** de Boulogne, Calais et Dunkerque. (2 500 tableaux & fig.)

1946 **656 .257**

Revue générale des chemins de fer, décembre, p.

CAMUS, MASCOT & DUGAS. — Deux utilisa originales des **serrures Bouré,** dans la reconstruction visoire de **postes d'aiguillage** de la Région du Nord S. N. C. F. (1 500 mots & fig.)

1946 **656 .225**

Revue générale des chemins de fer, décembre, p.

ANCELIN. — L'acheminement des colis sur la C. F. **Le wagonnage.** (2 500 mots & fig.)

1947 **621 .132 .3 (.44) & 621 .132 .5**

Revue générale des chemins de fer, janvier, p. 1.

LEGUILLE & PELLEVAT. — Etude et constr en Amérique de **1 340 locomotives à vapeur (série 1** pour la S. N. C. F. (10 000 mots & fig.)

1947 **656 .254**

Revue générale des chemins de fer, janvier, p. 20.

WALTER. — La mise en œuvre de **liaisons électriques** par la S. N. C F. (3 000 mots & fig.)

1947 **623 (.44) & 625 .13**

Revue générale des chemins de fer, janvier, p. 26.

Destructions et reconstructions sur les Chemins français (suite) : Le **souterrain** de Genevreuille (lig Paris à Bâle), par M. ODIOT. (2 200 mots & fig.)

La Technique moderne. (Paris.)

947 **621 .33 (.44)**

Technique moderne, 1er et 15 février, p. 63.

ectrification de la ligne Brive-Montauban. (600 mots.)

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947 **669**

Technique moderne, 1er et 15 mars, p. 73.

OURDILLON. — Le **traitement thermique des aciers lliages divers.** Progrès récents. (5 000 mots & fig.)

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947 **621 .116**

Technique moderne, 1er et 15 mars, p. 80.

MANAUD (M.). — La **chaudière « La Mont »** expé- ntée en service. (2 200 mots & fig.)

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947 **621 .438**

Technique moderne, 1er et 15 mars, p. 85.

turbine à gaz et la propulsion par réaction. (4 000 s & fig.)

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947 **621 .132 .8 (.44)**

Technique moderne, 1er et 15 mars, p. 91.

comotive à haute pression à essieux indépendants chemins de fer français. (2 000 mots & fig.)

In German.

Der Bahn-Ingenieur. (Berlin.)

943 **625 .17 (.44)**

Bahn-Ingenieur, Nr. 17, 15. Juli, S. 201.

CHTER (K.). — Die **Gleisunterhaltung** bei der Na- len Französischen Eisenbahngesellschaft (S.N.C.F.). 00 Wörter & Abb.)

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943 **656 .211 .5 (.43)**

Bahn-Ingenieur, Nr. 17, 15. Juli, S. 209.

ANGE. — **Gepäcküberfahrten in Schienenhöhe** chen Bahnsteigen. (400 Wörter & Abb.)

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943 **625 .151 (.43)**

Bahn-Ingenieur, Nr. 17, 15. Juli, S. 215.

SCHER (W.). — Über Zweck und Notwendigkeit der irkung des Betriebes bei **Weichenerneuerungen und chenauswechselungen.** (6 000 Wörter & Abb.)

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943 **621 .82 & 669**

Bahn-Ingenieur, Nr. 18, 15. August, S. 225.

AAS (Ph.) & SCHNEIDER (V.). — Die Unterschei- von **Weissmetallen** nach Gewicht. Ein Beitrag zur **offwirtschaft** der Deutschen Reichsbahn. (1 600 Wör- Tabellen & Abb.)

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943 **621 .392**

Bahn-Ingenieur, Nr. 18, 15. August, S. 240.

einschweissgeräte. (3 000 Wörter & Abb.)

1943 **625 .26 (.43)**

Der Bahn-Ingenieur, Nr. 19, 15. September, S. 251.

KRANE. — Praktische Vorrichtungen für die **Fahrzeugausbesserung** in den R. A. W. und B.w.w. (1 600 Wörter & Abb.)

1943 **625 .143 .4 & 656 .256 .3**

Der Bahn-Ingenieur, Nr. 19, 15. September, S. 254.

GLÄSEL & SPEELMANN. — Der **stromdichte Schienenstoss.** (1 300 Wörter & Abb.)

1943 **656 .221**

Der Bahn-Ingenieur, Nr. 19, 15. September, S. 260.

POTTHOFF. — Massgebende **Steigung und Anlaufsteigung.** (1 200 Wörter & Abb.)

1943 **388**

Der Bahn-Ingenieur, Nr. 19, 15. September, S. 263.

LEHNER (F.). — Die **Massen-Beförderungsmittel** einer Grossstadt. (Erwiderung zum Aufsatz von H. Ernicke-Heft 18/19 1942). (1 700 Wörter & 5 Tafeln.)

1943 **624. (0**

Der Bahn-Ingenieur, Nr. 20, 15. Oktober, S. 277.

HAILER (J.). — Berechnung der Quersteifigkeit der Tragwände oben offener **Brücken.** (4 500 Wörter & Abb.)

1943 **385 .587 (.43)**

Der Bahn-Ingenieur, Nr. 20, 15. Oktober, S. 287.

GITTINGER. — Die Fristentafel für die Gefolgschaft als Mittel zur **Leistungssteigerung** im Reichsbahn-Ausbesserungswerk. (1 600 Wörter & Abb.)

1943 **625 .174**

Der Bahn-Ingenieur, Nr. 21, 15. November, S. 304.

CAMRATH. — Die **elektrische Weichenheizung** als technische Massnahme zur Bewältigung von Betriebsschwierigkeiten, die ein harter Winter bringt. (7 000 Wörter, Tafeln & Abb.)

1943/44 **625 .143 & 665 .882**

Der Bahn-Ingenieur, Nr. 22, 15. Dezember, S. 328; Nr. 2, 15, Februar, S. 23; Nr. 5, 15. Mai, S. 95.

WENDT (O.). — Die **Azetylenflamme in der Gleisunterhaltung.** (18 000 Wörter & Abb.)

1944 **385 .587 & 621 .138 .5**

Der Bahn-Ingenieur, Nr. 1, 15. Januar, S. 2.

GITTINGER. — Durch welche Massnahmen sind **Leistungssteigerungen in Lokomotiv-Ausbesserungswerken** zu erreichen? (7 000 Wörter.)

1944 **385 .586 (.43)**

Der Bahn-Ingenieur, Nr. 1, 15. Januar, S. 13.

GÜNZEL (B.). — Erfahrungen und Grundsätze für die **betriebliche Anlernung und Umschulung.** (2 000 Wörter.)

1944 **385 .587 & 621 .91**

Der Bahn-Ingenieur, Nr. 3, 15. März, S. 45; Nr. 4, 15. April, S. 68.

RISSE (F.). — Die richtige Gestaltung, Anwendung und Instandhaltung der **Fräswerkzeuge**, ein Weg zur Leistungssteigerung. (8 000 Wörter, 6 Zahlentafeln & Abb.)

1944 **624 .2**

Der Bahn-Ingenieur, Nr. 3, 15. März, S. 58; Nr. 4, 15. April, S. 76.

HAILER (J.). — Ermittlung der **Durchbiegung der Hauptträger eiserner Brücken** mit Hilfe der an den Auflagern gemessenen Verdrehungswinkel. (5 000 Wörter & Abb.)

1944 **625 .142 (0**

Der Bahn-Ingenieur, Nr. 6, 15. Juni, S. 119.

SCHÜTZ (H.). — Das Verhalten der **Eisenbahnschwellen** bei Belastung. (1 200 Wörter, 2 Tafeln & Abb.)

1944 **625 .174**

Der Bahn-Ingenieur, Nr. 6, 15. Juni, S. 121.

SCHUPP (E.). — Die **Verhütung von Frostschäden.** (1 200 Wörter & Abb.)

Organ für die Fortschritte des Eisenbahnwesens. Glasers Annalen. (Berlin.)

1943 **621 .132 .8 (.436)**

Organ für die Fortschritte des Eisenbahnw. — Glasers Annalen, Heft 15/16, August, S. 236.

LEHNER (A.). — **Zahnradlokomotiven** der Ostmark. (6 000 Wörter & Abb.)

1943 **625 .151 & 656 .21 (01**

Organ für die Fortschritte des Eisenbahnw. — Glasers Annalen, Heft 15/16, August, S. 243.

POTTHOFF. — Die Zahl der **Fahrstrassenkreuzungen.** Ein Beitrag zur Bahnhofstopologie. (2 000 Wörter, 4 Tafeln & Abb.)

1943 **625 .42**

Organ für die Fortschritte des Eisenbahnw. — Glasers Annalen, Heft 15/16, August, S. 246.

BLOSS. — Sondergleise für **Untergrundbahnen.** (4 500 Wörter & Abb.)

1943 **385 (.4)**

Organ für die Fortschritte des Eisenbahnw. — Glasers Annalen, Heft 17/18, September, S. 253.

SCHWARZL (J.). — **Probleme des Eisenbahnwesens** im mittleren Donauraum. (12 000 Wörter & Abb.)

1943 **385 .112**

Organ für die Fortschritte des Eisenbahnw. — Glasers Annalen, Heft 17/18, September, S. 267.

BLOSS. — Das **Anlagekapital** der Eisenbahnen. (1 600 Wörter & Abb.)

1943 **385 .5**

Organ für die Fortschritte des Eisenbahnw. — G Annalen, Heft 17/18, September, S. 269.

SCHULZE-MANITIUS (H.). — Das Entstehe deutschen **Eisenbahn-Personals.** (3 000 Wörter & Ab

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1943 **385. (09**

Organ für die Fortschritte des Eisenbahnw. — G Annalen, Heft 17/18, September, S. 275.

WERNEKKE. — Die **Eisenbahnen von For** (2 000 Wörter & Karte.)

1943 **385. (09**

Organ für die Fortschritte des Eisenbahnw. — G Annalen, Heft 17/18, September, S. 277.

WERNEKKE. — Die **Eisenbahnen** von Mau (1 000 Wörter & Karte.)

1943 **385. (09**

Organ für die Fortschritte des Eisenbahnw. — G Annalen, Heft 17/18, September, S. 279.

WERNEKKE. — Die **Eisenbahnen** von Guyana. Wörter.)

1943 **621 .131 .3 & 621 .1**

Organ für die Fortschritte des Eisenbahnw. — G Annalen, Heft 19/20, Oktober, S. 283.

POSTUPALSKY (N.). — Die Ermittlung des meüberganges im Lokomotivkessel aus **Lokomot suchen.** (25 000 Wörter, 3 Tabellen & Abb.)

1943 **621 .135. (01, 625 .14 (01 & 625**

Organ für die Fortschritte des Eisenbahnw. — G Annalen, Heft 21/22, November, S. 317.

LEVEN (W.). — **Einfluss der Elastizität von zeug und Gleis auf die Führungskräfte** beim zeuglauf und auf die Stellung des Fahrzeugs im (14 000 Wörter, Tafeln & Abb.)

1943 **72**

Organ für die Fortschritte des Eisenbahnw. — G Annalen, Heft 21/22, November, S. 337.

REICHERT. — Abbruch von **Tunneln.** (8 000 W & Abb.)

1943 **6**

Organ für die Fortschritte des Eisenbahnw. — G Annalen, Heft 23/24, Dezember, S. 351.

POTTHOFF (G.). — Der **aussermittige Zusa stoss von Eisenbahnwagen.** (3 000 Wörter & Abb.

1943 **625 .**

Organ für die Fortschritte des Eisenbahnw. — G Annalen, Heft 23/24, Dezember, S. 355.

BLOSS. — Die **Zweischwelle.** (3 000 Wörter &

1943 **621 .431 .72 & 62**

Organ für die Fortschritte des Eisenbahnw. — G Annalen, Heft 23/24, Dezember, S. 359.

GRETZSCHEL & LANGENFELD. — **Heizung für Verbrennungstriebwagen** und für die zugel Steuer- und Beiwagen. (9 000 Wörter & Abb.)

43 **385.** (09 (.81)

n für die Fortschritte des Eisenbahnw. — Glasers Annalen, Heft 23/24, Dezember, S. 371.

HNEIDER (L.). — Von den **Brasilianischen Eisen-en.** (1 700 Wörter & Karte.)

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43 **625 .1** (.51 + 592)

n für die Fortschritte des Eisenbahnw. — Glasers Annalen, Heft 23/24, Dezember, S. 373.

ERNEKKE. — **Eisenbahnbrücken und Eisenbahn-**n Burma und Junnan. (1 000 Wörter.)

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43 **625 .174** (.494 + .55)

n für die Fortschritte des Eisenbahnw. — Glasers Annalen, Heft 23/24, Dezember, S. 376.

eepflüge. (400 Wörter & Abb.)

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44 **625 .232** (.43)

n für die Fortschritte des Eisenbahnw. — Glasers Annalen, Heft 1/2, Januar, S. 1.

n WALDSTÄTTEN. — Beitrag zur Entwicklung des **nen-Fernverkehrs.** (Doppelstock-Liegewagen.) (1 500 er & Abb.)

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44 **625 .2** (01 & **625 .215**

n für die Fortschritte des Eisenbahnw. — Glasers Annalen, Heft 1/2, Januar, S. 3.

RECKER (J.). — **Bewegungseinheiten.** (2 500 Wör- Abb.)

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44 **625 .211 & 625 .24**

n für die Fortschritte des Eisenbahnw. — Glasers Annalen, Heft 1/2, Januar, S. 6.

NKLER (A.). — **Statische Berechnung eines wagens** mit pyramidenförmiger Unterspannung. 0 Wörter & Abb.)

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44 **625 .112**

n für die Fortschritte des Eisenbahnw. — Glasers Annalen, Heft 1/2, Januar, S. 9.

TTHOFF (G.). — Die **Regelspur** 1 435 mm. (14 000 er & Abb.)

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44 **656 .254**

n für die Fortschritte des Eisenbahnw. — Glasers nnalen, Heft 3/4, Februar, S. 29.

SSLIN (R.). — Betrachtungen über das Durch-n beim **Zugmeldeverfahren** auf zweigleisigen ken. (6 000 Wörter, Tafeln & Abb.)

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44 **656 .25**

n für die Fortschritte des Eisenbahnw. — Glasers nnalen, Heft 3/4, Februar, S. 39.

SSE. — Winterschutzmassnahmen an **Eisenbahn-rungsanlagen** im besetzten Ostraum. (4 000 Wör-

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44 **625 .253**

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HUBERT (K.). — Beitrag zur Frage der nachträg- Ermittlung des wahrscheinlichen Bremsweges von **luftgebremsten Güterzügen.** (2 000 Wörter & Abb.)

1944 **621 .131 .3**

Organ für die Fortschritte des Eisenbahnw. — Glasers Annalen, Heft 3/4, Februar, S. 45.

SCHNEIDER (L.). — **Versuche** mit einer 2C1h2S. — Lokomotive von 4 300 PSi. (2 000 Wörter & Abb.)

1944 **621 .335** (.494)

Organ für die Fortschritte des Eisenbahnw. — Glasers Annalen, Heft 3/4, Februar, S. 48.

SCHMELZER. — Umbau einer 5/7 gekuppelten **Einphasenlokomotive** der Lötschbergbahn. (3 000 Wörter, Zusammenstellung & Abb.)

In English.

Bulletin, American Railway Engineering Association. (Chicago.)

1946 **69 & 725 .3**

Bulletin Amer. Railway Engineering Assoc., No. 463, December, p. 300.

Report of Committee 6. — **Buildings** : Use of recently developed building materials in railway buildings. (9 000 words.)

1946 **697 & 725 .33**

Bulletin Amer. Railway Engineering Assoc., No. 463, December, p. 319.

Report of Committee 6. — Buildings. **Ventilation** of railway shop buildings. (2 800 words & fig.)

1946 **625 .164**

Bulletin Amer. Railway Engineering Assoc., No. 463, December, p. 344.

Report of Committee 27. — Maintenance of Way. **Snow removal equipment.** (3 600 words & fig.)

1946 **625 .17**

Bulletin Amer. Railway Engineering Assoc., No. 463, December, p. 363.

Report of Committee 27. — Maintenance of Way. Machinery and equipment for **stabilizing roadbed.** (600 words & fig.)

The Engineer. (London.)

1947 **621 .135 .2** (.42)

Engineer, No. 4751, January 31, p. 133.

Fabricated steel **axleboxes.** (500 words & fig.)

1947 **656 .254** (.44)

Engineer, No. 4752, February 7, p. 157.

Radio communication in a french marshalling yard. (400 words & fig.)

1947 **621 .133 .1** (.44)

Engineer, No. 4753, February 14, p. 171.

Conversion of French locomotives to **oil-burning.** (300 words & fig.)

Modern Transport. (London.)

1946 **625 .232 (.42)**

Modern Transport, November 30, p. 4.

British-built **Royal Train** for South-Africa. (1 600 words & fig.)

1946/47 **625 .232 (.42)**

Modern Transport, November 30, p. 9; December 21, p. 14; December 28, p. 15; January 25, p. 6; February 15, p. 19.

British Railway Carriages, XXXII. — Passenger Communication. XXXIII. — Bells **versus** brakes, XXXIV. — Diners of « 93 », XXXV. — Centre corridor coaches, XXXVI. — Coaches of the « Nineties ». (6 000 words & fig.)

1946 **625 .23 (.73)**

Modern Transport, November 30, p. 8.

Transport conditions in the U. S. A. **Passenger rolling stock design.** (1 200 words.)

1946 **625 .244 (.42)**

Modern Transport, December 14, p. 11.

BRADBURY (W. P.). — **Refrigerated transport.** Developments on the L. M. S. (1 400 words.)

1946 **621 .136 .3 (.42) & 621 .392 (.42)**

Modern Transport, December 14, p. 15.

Welded construction for water-troughs. L. M. S. renewal at Hademore. (700 words & fig.)

1946 **625 .233**

Modern Transport, December 21, p. 15.

CUNNINGTON (A.) and GOLDS (G. W.). — **Railway lighting.** Past experience and pointers to the future. (1 200 words.)

1946 **625 .232 (.42)**

Modern Transport, December 21, p. 16.

New Southern Railway **passenger coaches.** (1 000 words & fig.)

1946 **656 (.42)**

Modern Transport, December 28, p. 5.

BLEE (D.). — **Road-rail rates problem.** Evolving a suitable structure. (1 200 words.)

1946 **385. (07 (.42)**

Modern Transport, December 28, p. 9.

TURNER (J. A. R.). — **Education and training** for transport. Facilities in the United Kingdom. (1 800 words.)

1947 **621 .431 .72 (.73)**

Modern Transport, January 4, p. 8.

Locomotive developments in the U. S. A. Progress in **Diesel electric traction.** Inspection and maintenance. (1 400 words & fig.)

1947 **621 .132 .3**

Modern Transport, January 11, p. 9; February 8,

POULTNEY (E. C.). — Landmarks of **express motives progress.** 1. The Caledonian « Dunalast (2 800 words & fig.)

1947 **656 .28**

Modern Transport, January 11, p. 14.

Buffer stop collision at Edgware. Report on c dental natural death. (600 words.)

1947 **656 .21**

Modern Transport, January 11, p. 19.

Work of a **stationmaster's office.** A wide ran duties. Importance of organisation. (600 words.)

1947 **656 .225 (.42) & 656 .226**

Modern Transport, January 18, p. 3.

BLEE (D.). — The **transhipment of goods-train fic.** (2 400 words & fig.)

1947 **385. (071 .3**

Modern Transport, January 18, p. 4.

Training Southern staff. New College at Woking. words & fig.)

1947 **385. (09**

Modern Transport, January 18, p. 8.

Railways in Italy. Their present state. (600 word

1947 **621 .132 .7 (.42) & 621 .335**

Modern Transport, January 18, p. 14.

Battery electric yard locomotives. Limited ran use. For light shunting and crane duties. (2 200 & fig.)

1947 **621 .132 .3**

Modern Transport, January 18, p. 19.

KLAPPER (C. F.). — **Steam locomotive possib** Need for high-speed machines. (900 words & fig.)

1947 **621 .138 (.42) & 656 .222 .1**

Modern Transport, January 25, p. 5; February 1,

RUDGARD (H.). — **Locomotive performanc** availability. (2 200 words & diagrams.)

1947 **621 .438 (.42) & 621 .335**

Modern Transport, January 25, p. 8.

Gas-turbine-electric locomotive. Metropolitan-V design for G. W. R. (600 words.)

1947 **621 .132 .3 (.68) & 621 .132 .5**

Modern Transport, February 1, p. 3.

Light 4-8-2 locomotives for South-African Railwa Harbours administration. (900 words & fig.)

621 .138 (.42) & 656 .222 .1 (.42)
Transport, February 1, p. 8.
OLD RUDGARD. — **Locomotive performance** ailability. (1 000 words & fig.)

625 .242 (.42)
Transport, February 1, p. 9.
wagons for L. M. S. All steel 16-Ton units. (900 & fig.)

621 .132 .3 (.42)
Transport, February 8, p. 7.
LTNEY (E. C.). — **Four-cylinder locomotives.** words & fig.)

385. (09 (.944)
Transport, February 15, p. 3.
vay operation in New South-Wales. (1 400 words

625 .232 (.42)
Transport, February 15, p. 19.
sh Railway Carriages. (1 400 words & fig.)

e Oil Engine and Gas Turbine (London.)

621 .438
l Engine, January, p. 298.
YAVIN (P.). — Developing the air compressor. rations of the requirements for blowers for the e-charging of piston engine and for units for **gas s.** (1 800 words & fig.)

621 .132 .8 (.42) & 621 .438 (.42)
Engine, January, p. 308.
G. W. R. - Metrovick **gas turbine locomotive.** ords.)

621 .438
l Engine, February, p. 320.
ary pressure exchanger. (1 200 words & fig.)

621 .438 (.42)
Engine, February, p. 332.
and three-shaft **gas turbine** designs. (1 100 words

621 .431 .72 (.42)
Engine, February, p. 333.
dual-purpose **Diesel-electric locomotive.** (400 & fig.)

Railway Age. (New York.)

625 .61 (01
Age, December 21, p. 1038.
RIGER (John W.). — **Travel test** should omit ntials. (3 500 words.)

1946 621 .138 .5 (.73) & 621 .431 .72 (.73)
Railway Age, December 21, p. 1047.
MORRIS (J. P.). — **Diesel-electric locomotive maintenance.** (1 800 words.)

1946 625 .143 .1 (.73)
Railway Age, December 21, p. 1060.
LAYNG (F. R.). — **Reducing upkeep costs with heavy rails.** (700 words & fig.)

1946 625 .23 (.73) & 669 (.73)
Railway Age, December 21, p. 1082.
Weight reductions in **passenger cars.** (2 400 words & fig.)

1947 656 .254 (.73)
Railway Age, January 4, p. 39.
DUNN (J. H.). — Much ahead in **modern signaling.** (1 800 words & fig.)

1947 656 .254 (.73)
Railway Age, January 4, p. 87.
DUNN (J. H.). — Fast changes in **communications.** (2 400 words & fig.)

1947 624 (.73)
Railway Age, January 11, p. 136.
All-aluminium bridge span makes debut. (900 words & fig.)

1947 656 .254 (.73)
Railway Age, January 11, p. 146.
Rio Grande installs **radio to improve through freight service.** (900 words & fig.)

1947 656 .237 (.73)
Railway Age, January 18, p. 180.
Photography eliminates bottlenecks. (900 words & fig.)

1947 625 .244 (.73)
Railway Age, January 18, p. 183.
F.G.E.X. experimental **refrigerator car.** (1 200 words & fig.)

1947 621 .431 .72 (.73)
Railway Age, January 25, p. 224.
GILLILAN (P. M.). — Alco-G. E. 70-ton **diesel locomotive.** (1 200 words & fig.)

1947 625 .143 .5 (.492)
Railway Age, January 25, p. 234.
MUNDT (TH.). — **Says rail chairs will prevent tie damage.** (400 words & fig.)

1947 621 .131 .2 (.73)
Railway Age, February 1, p. 265.
LOFTIS (J. D.). — The case for **head-end train power.** (2 600 words & fig.)

1947 **624 .5 (.73)**

Railway Age, February 1, p. 270.

ROBERTS (K. C.). — **Railroad bridge** « sails » to new position. (2 000 words & fig.)

1947 **625 .244 (.73)**

Railway Age, February 1, p. 273.

Santa Fe **stainless steel refrigerator car** is placed in test service. (1 000 words & fig.)

Railway Engineering and Maintenance. (Chicago.)

1946 **625 .141 (.73)**

Railway Engineering and Maintenance, July, p. 738.

Grouted roadbed holds up under special trackwork at busy St-Louis terminal. (3 300 words & fig.)

1946 **625 .142 .1 (.73)**

Railway Engineering and Maintenance, August, p. 831.

JEFFORDS (L. S.). — **Are nine-foot ties worth while?** (1 400 words & fig.)

1946 **621 .133 .7 (.73)**

Railway Engineering and Maintenance, August, p. 837.

Watering engines at 80 m.p.h. (300 words & fig.)

1946 **625 .154 (.73)**

Railway Engineering and Maintenance, August, p. 839.

Burlington devises better scheme for **renewing turntables.** (2 500 words & fig.)

1946 **656 .215 (.73)**

Railway Engineering and Maintenance, August, p. 843.

Small Station has radiant **heating** and other innovations. (1 700 words & fig.)

1946 **625 .154 (.73)**

Railway Engineering and Maintenance, September, p. 933.

Cushioning shock at ends of **turntables.** (600 words & fig.)

1946 **691 (.73) & 725 .33 (.73)**

Railway Engineering and Maintenance, September, p. 941.

Cathodic protection stops **tank corrosion.** (1 300 words & fig.)

1946 **721 .3 (.73)**

Railway Engineering and Maintenance, October, p. 1051.

Folding leads for pile drivers save time and reduce hazards. (1 100 words & fig.)

1946 **625 .144 .4 (.73)**

Railway Engineering and Maintenance, October, p. 1058.

Means of obtaining the maximum use of **maintenance of way powered equipment.** — Report of Committee. (1 800 words & fig.)

1946 **625 .173**

Railway Engineering and Maintenance, October, p

Inspection of rail by track forces. — Report o mittee. (1 900 words & fig.)

1946 **625 .144**

Railway Engineering and Maintenance, Nov p. 1177.

BEEBE (T. H.). — **Big special-trackwork** jo in smoothly. (3 400 words & fig.)

1946 **625 .15**

Railway Engineering and Maintenance, Nov p. 1193.

Adopting **turntables** to meet modern conditions. port of Committee. (3 200 words & fig.)

1946 **69**

Railway Engineering and Maintenance, Nov p. 1196.

Methods of improving strength, durability an resistance of **concretes.** (4 000 words & fig.)

1946 **625 .143**

Railway Engineering and Maintenance, De p. 1291.

MAGEE (G. M.). — **Tie plates.** What si design ? (1 800 words & fig.)

1946 **625 .16**

Railway Engineering and Maintenance, De p. 1294.

Machines keep terminals open in winter on C (1 500 words & fig.)

1946 **725 .3**

Railway Engineering and Maintenance, De p. 1298.

Large **concrete building** takes a trip. (1 800 v fig.)

1946 **625 .1**

Railway Engineering and Maintenance, De p. 1301.

Open deck on overhead bridge reduces **upkee** (600 words & fig.)

1946 **625 .144**

Railway Engineering and Maintenance, De p. 1303.

On-track **grouting machine** used effectively on t (1 200 words & fig.)

1947 **69**

Railway Engineering and Maintenance, January

HERBERT I. BENJAMIN. — **Preventing railway structures.** (2 800 words & fig.)

1947 **625 .17**

Railway Engineering and Maintenance, January

PROTZELLER (H. W.). — The « Why » « How » of **ballast cleaning.** (5 800 words & fig.

625 .13 (.73) & 625 .141 (.73)
y Engineering and Maintenance, January, p. 56.
« Mud Boils » in Tunnel. With **pressure grout-** 200 words & fig.)

Railway Gazette. (London.)

625 .231 (.42)
y Gazette, No. 16, October 18, p. 443.
lightweight postal vans. (900 words & fig.)

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385 .3 (.42)
y Gazette, No. 16, October 18, p. 452.
sh Railways and the future. (2 000 words.)

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385 .3 (.42)
y Gazette, No. 16. October 18, p. 453.
State and the railways. (1 400 words.)

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621 .392 (.73)
y Gazette, No. 17, October 25, p. 470.
ay applications of **welding** in America. (1 100

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621 .132 .3 (.42)
y Gazette, No. 17, October 25, p. 472.
locomotives for L. M. S. R. (N. C. C.). (700 & fig.)

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621 .33 (.944)
y Gazette, No. 18, November 1, p. 498.
ic detection of circuit faults. (350 words & fig.)

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621 .335 (.494)
y Gazette, No. 19, November 8, p. 526.
lightweigt electric locomotives. A new design speed inter-city expresses. (900 words & fig.)

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621 .33 (.44)
y Gazette, No. 19, November 8, p. 527.
h Railway **electrification** plans. (350 words & .)

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625 .172 (.42)
y Gazette, No. 19, November 8, p. 528.
eledetector car. (700 words & fig.)

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656 .21 (.42)
y Gazette, No. 20, November 15, p. 551.
lesign of **railway stations.** Sir Charles H. New- ief General Manager, L. N. E. R., on the future on termini. (1 500 words.)

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621 .133 .1 (.42)
Gazette, No. 20, November 15, p. 553.
LESS (T.). — **Oil-fuel burning** on locomotives. ords, fig. & diagram.)

1946 625 .232 (.42)
Railway Gazette, No. 20, November 15, p. 557.
G. W. R. Standard **third class coaches.** (600 words & fig.)

1946 385 .57 (.42)
Railway Gazette, No. 21, November 22, p. 573; No. 22, November 29, p. 601.
L. N. E. R. **staff selection and training.** — 1. (2 200 words.)

1946 656 .2 (.73)
Railway Gazette, No. 21, November 22, p. 577.
Modern United States **operating methods.** (2 900 words.)

1946 621 .132 .8 (.42) & 621 .438 (.42)
Railway Gazette, No. 21, November 22, p. 579.
Gas turbine-electric locomotive for G. W. R. (700 words & fig.)

1946 621 .132 .8 & 621 .438
Railway Gazette, No. 21, November 22, p. 580.
Gas turbines for railway traction. (4 000 words, fig. & diagrams.)

1946 656 .251 (.42)
Railway Gazette, No. 22, November 29, p. 605.
Southern Railway **colour-light signalling.** (300 words & map.)

1946 625 .142 (.73)
Railway Gazette, No. 22, November 29, p. 616.
A mechanical **sleeper-handling plant.** (1 200 words & fig.)

1946 621 .133 .7 (.73)
Railway Gazette, No. 22, November 29, p. 617.
Modern **water troughs** in the United States. (200 words & fig.)

1946 621 .133 .7 (.42)
Railway Gazette, No. 22, November 29, p. 621.
Welded **water troughs** on the L. M. S. R. (900 words.)

1946 385 .15 (.42)
Railway Gazette, No. 23, December 6, p. 634.
The **transport bill.** (4 000 words.)

1946 656 .254 (.42)
Railway Gazette, No. 23, December 6, p. 637.
Telephones on trains. (180 words & fig.)

1946 621 .431 .72 (.481)
Railway Gazette, No. 23, December 6, p. 640.
Recent **traction developments** in Sweden. (460 words & fig.)

1946 **656 .225 (.42) & 625 .244 (.42)**

Railway Gazette, No. 24, December 13, p. 662.

Refrigerator transport by rail. Methods and refrigerants on the L. M. S. R. system. (1 100 words.)

1946 **621 .131 .1 (.73)**

Railway Gazette, No. 24, December 13, p. 663.

Locomotive performance on an American line. Comparison of results obtained with 4-8-4 and articulated types of locomotives on the Norfolk & Western Railway. (900 words & diagram.)

1946 **656 .262 (.42)**

Railway Gazette, No. 24, December 13, p. 665.

L. M. S. R. **hostels for trainmen.** (1 400 words & fig.)

1946 **625 .1 (.42)**

Railway Gazette, No. 24, December 13, p. 673.

L. N. E. R. £ 50 000 000 **development programme.** (600 words & diagram.)

1946 **621 .135. (01**

Railway Gazette, No. 25, December 20, p. 691.

McARD (G. W.). — **Inertia effects on locomotive connecting rods** and reciprocating parts at high speed. (1 200 words & fig.)

1946 **621 .431 .72 (.437)**

Railway Gazette, No. 25, December 20, p. 696.

Restoration of the « **Slovak Arrow** » **service.** (500 words & fig.)

1946 **625 .251**

Railway Gazette, No. 26, December 27, p. 714.

The **braking of railway vehicles.** (1 400 words & fig.)

1946 **621 .132 .5 (.73)**

Railway Gazette, No. 26. December 27, p. 717.

POULTNEY (E. C.). — **High-power freight locomotives,** Pennsylvania RR. (1 600 words & fig.)

1947 **621 .33 (.42)**

Railway Gazette, No. 1, January 3, p. 10.

The only British **freight railway electrification.** (600 words & map.)

1947 **621 .33 (.42) & 625 .172 (.42)**

Railway Gazette, No. 1, January 3, p. 11.

Avoiding ice formation on conductor rails. (500 words.)

1947 **625 .172 (.42)**

Railway Gazette, No. 1, January 3, p. 11.

London Transport **anti-frost measures.** (400 words.)

1947 **656 .212 .5 (.42)**

Railway Gazette, No. 1, January 3, p. 12.

KUBALE (J. C.). — Modern **marshalling yards.** (2 100 words.)

1947 **621 .132 .**

Railway Gazette, No. 1, January 3, p. 14.

New L. M. S. R. locomotives. 2-6-0 tender a tank locomotives for secondary services. (1 40 & fig.)

1947 **625 .23**

Railway Gazette, No. 1, January 3, p. 17.

New Southern Railway **main-line coaches.** (60 & fig.)

1947 **625 .144**

Railway Gazette, No. 2, January 10, p. 36.

G. W. R. **track** in 1946. (500 words.)

1947 **621 .3**

Railway Gazette, No. 2, January 10, p. 42.

Developments in **railway lighting.** (800 words

1947 **621 .131**

Railway Gazette, No. 2, January 10, p. 43.

New locomotives for the Central and Southe ways of Peru. (800 words & fig.)

1947 **385 (071**

Railway Gazette, No. 2, January 10, p. 44.

Testing L. N. E. R. **inquiry office servic** words.)

1947 **656 .256 .3**

Railway Gazette, No. 2, January 10, p. 45.

Power interlocking in Spain. (2 000 words & f

1947 **656 .**

Railway Gazette, No. 2, January 10, p. 56.

Ministry of Transport : **Accident report.** Ba crossing, L. M. S. R., July 25, 1946. (700 wo

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1947 **621 .132 .8 (.73) & 621 .4**

Railway Gazette, No. 3, January 17, p. 71.

The **coal-fired gas turbine locomotive.** (1 100 fig.)

1947 **625 .144 .4 (.42) & 625 .**

Railway Gazette, No. 3, January 17, p. 73.

MATHESON (E. J. M.). — G. W. R. **demo train.** (1 500 words & fig.)

1947 **625 .2**

Railway Gazette, No. 3, January 17, p. 77.

New **streamline trains** in U. S. A. (600 word

1947 **656 .2**

Railway Gazette, No. 3, January 17, p. 81.

Ministry of Transport **accident report.** Hatfie E. R. : July 15, 1946. (2 200 words & fig.)

656 .226 (.42)
Gazette, No. 4, January 24, p. 101.
iting **miscellaneous traffic** on the L. M. S. R.
ords, fig. & maps.)

621 .32 (.42)
Gazette, No. 4, January 24, p. 106.
s heating by valve generators. (500 words & fig.)

656 .283 (.42)
Gazette, No. 4, January 24, p. 110.
ry of Transport : **Accident report.** Edgware,
. B. : July 27, 1946. (1 000 words.)

625 .14 (06 (.42)
Gazette, No. 4, January 24, p. 112.
nent Way Institution annual meeting and dinner.
ords.)

621 .33 (.42)
Gazette, No. 5, January 31, p. 134.
ay electrification in Great Britain. (700 words.)

621 .33 (.492)
Gazette, No. 5, January 31, p. 135.
ification in Holland. (300 words.)

621 .132 .3 (.42)
Gazette, No. 5, January 31, p. 136.
lt « Patriot » class locomotives, L. M. S. R. (700
fig.)

621 .438 (.43)
Gazette, No. 6, February 7, p. 158.
development of **gas turbine power plants for purposes** in Germany. (1 700 words.)

621 .132 .6 (.54)
Gazette, No. 6, February 7, p. 164 & 170.
2-8-2 class « XD » tender locomotives for India.
ords & fig.)

621 .133 .7
Gazette No. 7, February 14, p. 187.
cation of base-exchange **water softeners** to rail-
3 500 words.)

way Mechanical Engineer. (New York.)

621 .132 .8 (.73) & 621 .431 .72 (.73)
Mechanical Engineer, November, p. 606.
Fairbanks-Morse road **Diesel locomotive.** (2 400
fig.)

625 .232 (.73)
Mechanical Engineer, November, p. 611.
about old passenger train cars ? (4 000 words &

1946 621 .132 .8 (.73) & 621 .438 (.73)
Railway Mechanical Engineer, November, p. 615.
YELLOTT (J. I.) & KOTTCAMP (C. F.). — The **coal-fired gas turbine locomotive.** (5 400 words & fig.)

1946 621 .138 .3 (.73)
Railway Mechanical Engineer, November, p. 629.
Locomotive washing and stripping rack. (1 800 words & fig.)

1946 625 .244 (.73)
Railway Mechanical Engineer, December, p. 645.
Illinois Central **aluminium refrigerator car.** (1 400 words & fig.)

1946 621 .132 .8 (.73) & 621 .431 .72 (.73)
Railway Mechanical Engineer, December, p. 649.
Santa Fe **6 000-HP. Diesel.** (3 200 words & fig.)

1946 621 .13 (.73)
Railway Mechanical Engineer, December, p. 656.
POND (C. E.). — The Norfolk & Western use of **modern steam locomotives.** (2 100 words & fig.)

1946 656 .254 (.73)
Railway Mechanical Engineer, December, p. 676.
TRIEM (W. R.). — The **carryphone** takes a bow. (800 words & fig.)

1946 621 .138 .5 (.73)
Railway Mechanical Engineer, December, p. 677.
Cleaning **traction motors.** (1 200 words & fig.)

1946 656 .254 (.73)
Railway Mechanical Engineer, December, p. 679.
Air conditioning and **radio.** (3 000 words & fig.)

1947 621 .138 .5 (.73)
Railway Mechanical Engineer, January, p. 1.
MORRIS (J. P.). — Maintenance of **Diesel power.** (3 200 words.)

1947 625 .23 (.73)
Railway Mechanical Engineer, January, p. 4.
KIEFER (P. W.). — **Passenger-car weight.** (2 800 words.)

1947 621 .133 .3 (.73)
Railway Mechanical Engineer, January, p. 6.
MILLER (H. L.). — **Welded locomotive boiler.** (5 600 words & fig.)

1947 656 .284 (.73)
Railway Mechanical Engineer, January, p. 19.
LONGHURST (H. R.). — **Hot boxes** in freight service. (3 000 words & fig.)

1947 **621 .131 .2 (.73)**

Railway Mechanical Engineer, January, p. 24.

JAMES GRANT. — **Locomotive failures.** (3 200 words.)

1947 **621 .33 (.73)**

Railway Mechanical Engineer, January, p. 35.

MARSHALL (W. C.). — **Lower electrical maintenance.** (2 800 words.)

In Spanish.

Ferrocarriles y Tranvias. (Madrid.)

1946 **385 .114 & 656 .222 .4**

Ferrocarriles y Tranvias, mayo, p. 220.

MARTINEZ de VELASCO (R.). — Relaciones entre la **capacidad de transporte del ferrocarril** y el costo total de aquél. (2 500 palabras & fig.)

1946 **385. (09 (.460)**

Ferrocarriles y Tranvias, junio, p. 259.

WAIS (F.). — Los **ferrocarriles** de Vizcaya. (5 500 palabras & fig.)

1946 **621 .33 (.460)**

Ferrocarriles y Tranvias, junio, p. 286.

GUERRICABEITIA (J. A.). — **Electrificación** del ramal de Durango a Ellorio de la Compañia de los Ferrocarriles Vascongados. (2 500 palabras & fig.)

1946 **625 .254**

Ferrocarriles y Tranvias, junio, p. 292.

BORREGUERO PADRO (J. G.). — **El freno automâtico de vacio** en ferrocarriles. (4 500 palabras & fig.)

1946 **621 .134 .1**

Ferrocarriles y Tranvias, junio, p. 303.

TOBALINA (J.-M.). — La fabricación de **cilindros de locomotoras** y las especificaciones técnicas unificadas. (4 000 palabras & fig.)

1946 **621 .132 .5 (.460)**

Ferrocarriles y Tranvias, junio, p. 326.

Nuevas mejoras en el material de la RENFE. Locomotoras Montaña, serie 4 600. (800 palabras & fig.)

1946 **621 .135 .2 (.460) & 625 .214 (.460)**

Ferrocarriles y Tranvias, junio, p. 328.

Rodamientos SKF en ferrocarriles españoles. (800 palabras & fig.)

1946 **625 .245 (.460)**

Ferrocarriles y Tranvias, julio, p. 370.

ALEIXANDRE Y LOPEZ PUIGCEVER (H.-M.). — Proyecto de nuevos **vagones especiales.** (4 000 palabras & fig.)

1946 **621 .392 & 625**

Ferrocarriles y Tranvias, julio, p. 378.

MONEVA (F.). — La **soldadura aluminotérr carriles** en las lineas férreas. (5 500 palabras.)

1946 **656 .257**

Ferrocarriles y Tranvias, agosto, p. 430.

LAPORTE SAENZ (E.). — El **enclavamiento** Ericsson de la estación de Pozuelo. (9 000 pala fig.)

1946 **621 .133 .1 (.460) & 621 .133 .2**

Ferrocarriles y Tranvias, agosto, p. 444.

VILLAR (M.). — Los **quemadores de fuel-oil** ferrocarriles españoles. (4 000 palabras & fig.)

1946 **625 .113 (.460) & 656 .22**

Ferrocarriles y Tranvias, septiembre, p. 477.

MENDIZABAL (D.). — **Principales caracteris las lineas ferroviarias** españolas y su influencia explotación. (5 000 palabras & 15 cuadros.)

1946 **385. (09 .3**

Ferrocarriles y Tranvias, septiembre, p. 495.

de la FUENTE (J.). — El próximo **centenario rocarril** en España. (4 000 palabras.)

1946 **6**

Ferrocarriles y Tranvias, noviembre, p. 569 & di p. 624.

GOITISOLO (I.). — Nuevas orientaciones y lidades futuras del **alumbrado eléctrico de trenes.** palabras & fig.)

1946 **6**

Ferrocarriles y Tranvias, noviembre, p. 580.

MORALES (G. P.). — Estudio sobre vanos, descentramiento de una **catenaria.** (1 600 palabras

In Italian.

L'Ingegnere. (Milano.)

1947

L'Ingegnere, gennaio, p. 31.

PELLEGRINI (B.). — Il **calcolo della trave deel** col metodo dell' ellisse d' elasticità. (4 00 & fig.)

In Dutch.

Spoor- en Tramwegen. (Utrecht.)

1944 **6**

Spoor- en Tramwegen, Nr 14, 1 Juli, p. 163.

HUG (Ad.-M.). — **Aandrijving en tandwielo ging bij electrische voertuigen.** (1 500 woorden &

656 .136

n Tramwegen, Nr 14, 1 Juli, p. 165.
(W.). — **Electrisch wegvervoer.** (1 500 woorden

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625 .244

en Tramwegen, Nr 15, 15 Juli, p. 175.
NIUS (K. H.). — **Vischvervoer per spoor.** voorden.)

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656 .222 .6

en Tramwegen, Nr 16, 29 Juli, p. 189.
WEEL (J. R.). — De conjunctuur en het **goe-rvoer** per spoor. (1 500 woorden.)

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385. (09 (.61)

en Tramwegen, Nr 16, 29 Juli, p. 191.
oorwegen in Tunis. (1 200 woorden & fig.)

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625 .232 (.494)

en Tramwegen, Nr 17, 12 Augustus, p. 206.
ve lichte stalen rijtuigen der S. B. B. (1 200 woor-ig.)

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629 .113 .4 (.492)

en Tramwegen, Nr 18, 26 Augustus, p. 213.
RMANN (J.). — **Gastractie** bij de N. S. en ondernemingen. (3 000 woorden & fig.)

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385 .1 (.492)

en Tramwegen, Nr 1, 11 October, p. 4.
OT (A. M.). — De ontwikkeling van de **finan-ositie** van N. S. gedurende den oorlog. (1 200 n.)

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623 (.492)

en Tramwegen, Nr 4, 22 November, p. 25.
ederlandsche Spoorwegen na den oorlog. (1 600 n & fig.)

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621 .335 (.494)

en Tramwegen, Nr 5, 6 December, p. 37.
EYER (A. G.). — De **nieuwe Gotthardlocomo-**van de S. B. B. (1 000 woorden & fig.)

1945/1946 **625 .42 (.492)**

Spoor- en Tramwegen, Nr 6, 20 December, p. 41; Nr 7, 3 Januari, p. 53; Nr 8, 17 Januari, p. 69.

PLOMP (A.). — Leent de Nederlandsche bodem zich voor **ondergrondsche spoorwegen ?** (6 000 woorden & fig.)

1946 **656 .235 (.492)**

Spoor- en Tramwegen, Nr 8, 17 Januari, p. 63; Nr 9, 31 Januari, p. 79; Nr 10, 14 Februari, p. 93.

BOENDER (P.). — **Prijsregeling in het goederenver-voer.** (8 000 woorden.)

1946 **621 .132 .3 (.492) & 621 .132 .5 (.492)**

Spoor- en Tramwegen, Nr 8, 17 Januari, p. 66.

de PATER (A. D.). — De **Engelsche en Ameri-kaansche locomotieven** die thans bij de N. S. dienst doen. (2 500 woorden & fig.)

1946 **385 (.42)**

Spoor- en Tramwegen, Nr 12, 14 Maart, p. 121.

TISSOT VAN PATOT (J. P. B.). — Het **nationali-satie-vraagstuk** en het Britische vervoer. (2 500 woor-den.)

1946 **621 .132 .5 (.44)**

Spoor- en Tramwegen, Nr 12, 14 Maart, p. 124.

NYMEYER (A. G.). — De **locomotieven serie 141-P** van de S. N. C. F. (1 300 woorden & fig.)

1946 **623 (.492)**

Spoor- en Tramwegen, Nr 13, 28 Maart, p. 135; Nr 20, 4 Juli, p. 233.

LUCARDIE (J. P. S.). — De **Nederlandsche Spoor-wegen** tijdens de bevrijding en hun waarde voor de geal-lieerde oorlogvoering. (6 000 woorden & fig.)

1946 **621 .431 .72 (.493) & 625 .215 (.493)**

Spoor- en Tramwegen, Nr 13, 28 Maart, p. 137.

NYMEYER (A. G.). — De **motordraaistellen met onafhankelijke afveering** van de motorrijtuigen der Bel-gische spoorwegen. (700 woorden & fig.)

1946 **621. 33 (.492)**

Spoor- en Tramwegen, Nr 14, 11 April, p. 154.

NYMEYER (A. G.). — Het **electrificatieprogramma** der Fransche spoorwegen. (3 000 woorden & fig.)

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